

A NURSE SCHEDULING SYSTEM

**CENTRE FOR NEWFOUNDLAND STUDIES**

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**A NURSE SCHEDULING SYSTEM**

**BY**



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### ABSTRACT

A nurse scheduling system is proposed as a solution to the present random manner of scheduling nursing personnel in a 354-bed hospital. The system solves the existing problems yet is general enough to be used by any hospital. It provides an objective method to schedule and allocate nursing staff. Computer programs are written to aid in the solution of the problem. Cyclic work schedules are assembled subject to hospital and contract constraints. Work schedules are projected in advance for both the individual and the unit.

Daily assignment of staff to units is based on a workload index. Data for the workload index was collected by the nurses using a new and unique form of time study. Management reports for evaluation and control are designed. This report shows how substantial improvements in staff utilization can be made by using an objective allocation method. Interest here is in achieving an optimal utilization of available nursing resources.

## PREFACE

Project Management provides an excellent opportunity to tackle a resource scheduling and allocation problem in an engineering area. The health services area is selected here and a method proposed which provides an optimal use of available nursing resources.

I must express my gratitude to the Administration and nursing staff of the General Hospital at St. John's, Newfoundland who kindly allowed me to conduct the research and provided any assistance required during the project. A special thank-you to Mrs. Schofield and the nursing staff on Neurology and 2-N Ward for their participation and help over the past months. Other help from computer services and colleagues has been greatly appreciated.

I am also indebted to my supervisor, Professor H. N. Ahuja, who provided many hours of instruction and guidance during my program.

Robert Sheppard

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## 1. INTRODUCTION

The scheduling of nursing personnel is generally considered by hospital administrators to be one of the most important problems in the operational management of hospitals. By far the largest single cost factor in the hospital budget is the salaries of nursing staff, typically about one-quarter of the hospital budget. This represents three and one-half million dollars spent on nursing salaries for the General Hospital.

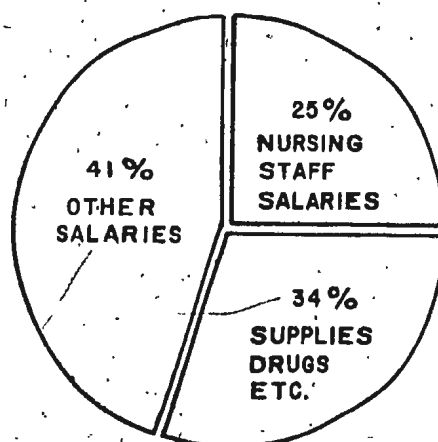


Figure 1. Portion of Hospital Budget Spent on Nursing Salaries.

"Between 1960 and 1969 hospital expenditures in Canada averaged an annual growth of 14.5%." <sup>1</sup> Public expectation of more and better health services and the move toward universal health insurance have contributed to increasing costs. These costs can be expected to rise.

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<sup>1</sup> Branching Out Vol. II, Report of the Canadian Computer/Communications Task Force, Information Canada, Ottawa, 1972, page 137.

The importance of achieving greater efficiency in scheduling personnel is depicted by the influence of three major trends:<sup>[3]</sup>

1. The rising salaries of nursing personnel,
2. The growing pressures on hospitals to contain costs and,
3. An apparent shortage of qualified personnel.

Scheduling is especially laborious in the patient care services area where, in addition to a seven day week, twenty-four hour coverage, the patient workload and available qualified staff continually fluctuate. According to Murray<sup>[35]</sup>, the time spent on scheduling can take one hour per bed per month of primarily nursing supervisor time.

"Schuette<sup>[44]</sup> found that the time spent at the University of Michigan to be about half of that, but without including some associated clerical tasks. Although this time is divided between gathering individual requests for days off, determining a schedule, and then making changes to the schedule after it is posted, the major part [about 70% according to Schuette] is in arriving at a schedule.

While the most tangible justification for improving the scheduling process is in reducing the amount of time needed to develop schedules, the more significant justification lies in that better "quality" schedules can be produced. Melbin<sup>[32]</sup>, for instance, has shown that there is a relation between the schedules that nurses work and turnover, absenteeism, and lateness."<sup>2</sup>

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<sup>2</sup> Warner, D.M., page 9, Ref. 51 of Bibliography.

## 1.1 ENVIRONMENT

### 1.1.1 Existing Scheduling Procedure

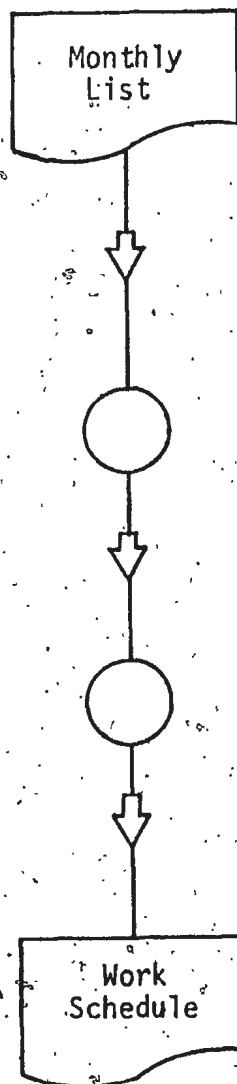
The head nurse usually does all the scheduling for the patient unit for which she is responsible. She meets each day's demands with the nursing staff<sup>3</sup> assigned to her specific unit. She estimates the patient care requirements for her unit and produces a work schedule to satisfy these requirements in addition to hospital policies and union contracts.

The head nurse tries to schedule the nursing staff so that each person gets her share of weekends off, and that none of the nurses is rotated to evening or night shifts for an undue period of time. Individual requests for specific days off are accommodated as much as possible. A schedule denoting work days and days off, usually for a four week period, is posted one week in advance. The general flow of the schedule sheet is shown in Figure 2.

Nursing office reserves the right to move a staff member from one unit to another to cover any severe shortage. No formal method of allocation is used but when unexpected peaks in workload occur which are really acute, then nursing staff are requested to move to the unit which is short of staff.

---

<sup>3</sup> In this study Registered Nurse (RN), Nurse Intern (NI), Nursing Assistant (NA).



List of names of staff  
required for coming month  
filled in on schedule at  
personnel office.

To head nurse.

Schedule filled in by  
head nurse.

To personnel office.

Checked and typed.

To head nurse.

Posted at nursing unit.

Figure 2. General Flow of Schedule Sheet.

### 1.1.2 Problems with Existing Scheduling Procedure

There are some problems associated with current procedures:

1. Preparation of the schedule by the head nurse takes considerable time. This is estimated according to Murray [35] to be 354 hours per month for a 354-bed hospital.
2. There is no set work pattern. Consequently, the work schedules vary from month to month which makes it difficult for nursing staff to plan time off.
3. Regular<sup>4</sup> personnel get second choice of time periods because part-time<sup>5</sup> and permanent<sup>6</sup> shift staff are scheduled first.
4. There is an unequal distribution of shifts.
5. Head nurses who make up the schedules consider individual preferences and requests, which is reasonable, but leaves them open to potential charges of favouritism.
6. There are many short term changes in the schedule because of turnover, absenteeism, annual leave and requests for time off.

---

<sup>4</sup> Work any shifts.

<sup>5</sup> Work less than five shifts per week.

<sup>6</sup> Work only evening or night shifts.

7. Scheduling is decentralized. Each head nurse submits her schedule to the nursing office monthly for approval, typing and posting. She has to effectively cover shortages and heavy workload with the nursing personnel assigned to her unit. Because help is available from the nursing office only in cases of severe fluctuation in workload or acute shortage, then there exists a tendency to maintain a safe level of staff on the unit. This level may be slightly in excess of the required number of staff. A nursing organization chart is shown in Appendix D.
8. No objective method is used to adjust staff to meet patient needs. This results in low utilization of available nursing resources. The graph in Figure 3 shows the number of nursing hours required (as obtained from the time study on the Neurology Unit; the day shift, from February 16 to March 1, 1974 at the General Hospital) and the actual number of nursing hours of care provided. Work measurement studies have shown that nursing hours are essentially wasted when no mechanism exists in the scheduling system for responding to short-term fluctuations in patient demands. [2]



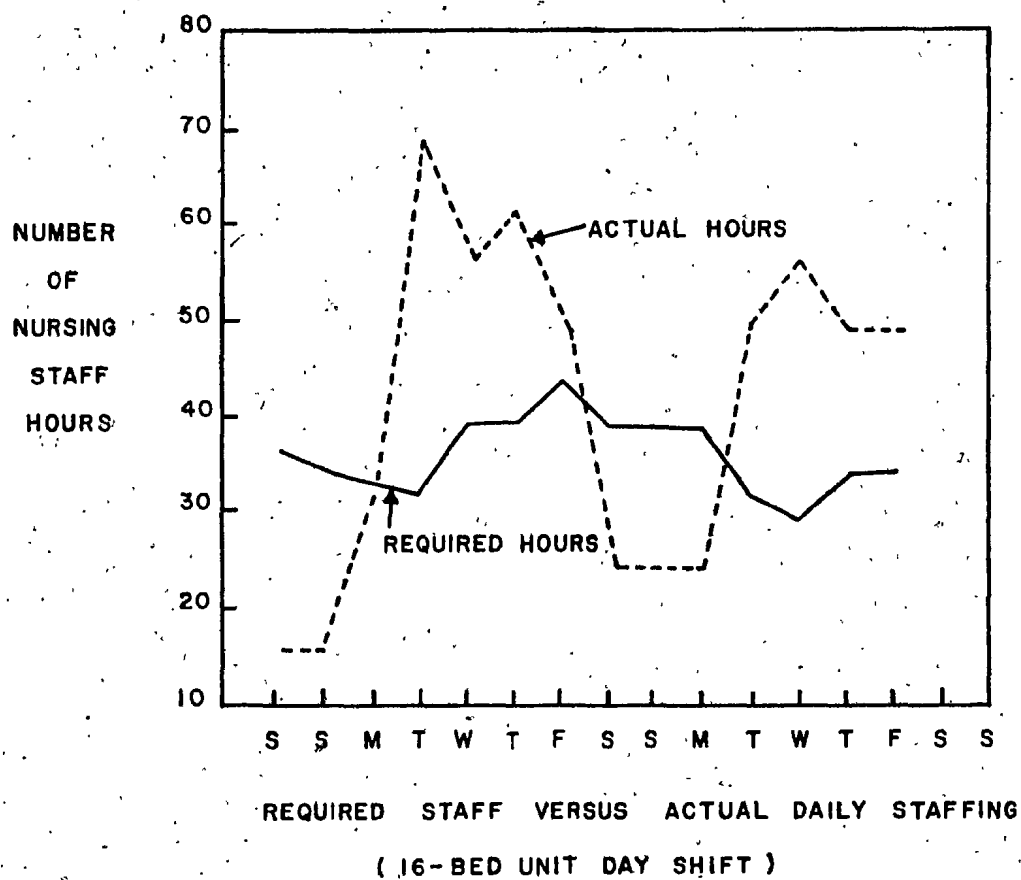


Figure 3. Typical Utilization Graph.

### 1.1.3 Constraints

The scheduling of nursing staff is fairly complex because of the variety of factors that must be considered. The constraints can be broken down into five main areas [25] which are:

#### 1. Pattern

This refers to the pattern of days on and off in a given schedule. For example, work contracts require that employees have one weekend off in four or one weekend off in three where possible.

#### 2. Stretch

This refers to the number of consecutive days worked in a schedule between days off. For example, the maximum work stretch may be seven days and the minimum three days. Long stretches of consecutive working days are considered undesirable because fatigue develops.

#### 3. Coverage

A certain number of nursing personnel is required on each shift to provide patient care. For example, each shift must contain at least one professional staff member (RN or NI) supplemented with nursing assistants. Staff levels are usually reduced on evening shifts, night shifts and weekends.

#### 4. Policy

This refers to specific hospital policies that affect the type of schedule produced on the nursing unit. For example, a nurse intern policy which states that interns must work 50% of their time on day shift affects the kind of schedule produced. Union contracts and rotation policies also influence the nature of the schedule produced.

#### 5. Sociological

The preferences of a particular group or segment of the work force is important in working out an acceptable schedule. For example, having weekends off is highly valued by the nursing staff. Next in preference is having two consecutive days off in the middle of the week. Working an evening or night shift on Friday before a weekend off is disliked very much because it consumes part of the weekend in recovering from the previous work shift. Excessive rotation is also undesirable because of insufficient rest time between shifts.

## 1.2 SCOPE

According to Abernathy, Baloff and Hershey [2] the nurse scheduling process can be organized into three phases of administrative action:

### 1. Planning

Planning consists of two major tasks - forecasting demand on the facility and budgeting over the planning period. One comprehensive forecast is usually prepared by the hospital for an entire year as part of an annual budgeting process. Budgeting is the task of determining the number of nursing personnel of each type (RN's, NI's, NA's) which are required for each shift on each unit to meet forecasted patient demand.

### 2. Short-term Scheduling

This consists of determining the work schedules for each unit and adjusting nursing staff daily to meet variations in patient needs.

### 3. Evaluation and Control

This element of the nurse scheduling system is an on-going process that compares the forecast and budget with the actual performance. This repetitive process aims to improve forecasts so that a greater degree of control over scheduling is achieved.

A total picture of the nurse scheduling process is given in Figure 4. The system developed in this study concentrates on the latter two areas: short-term scheduling, evaluation

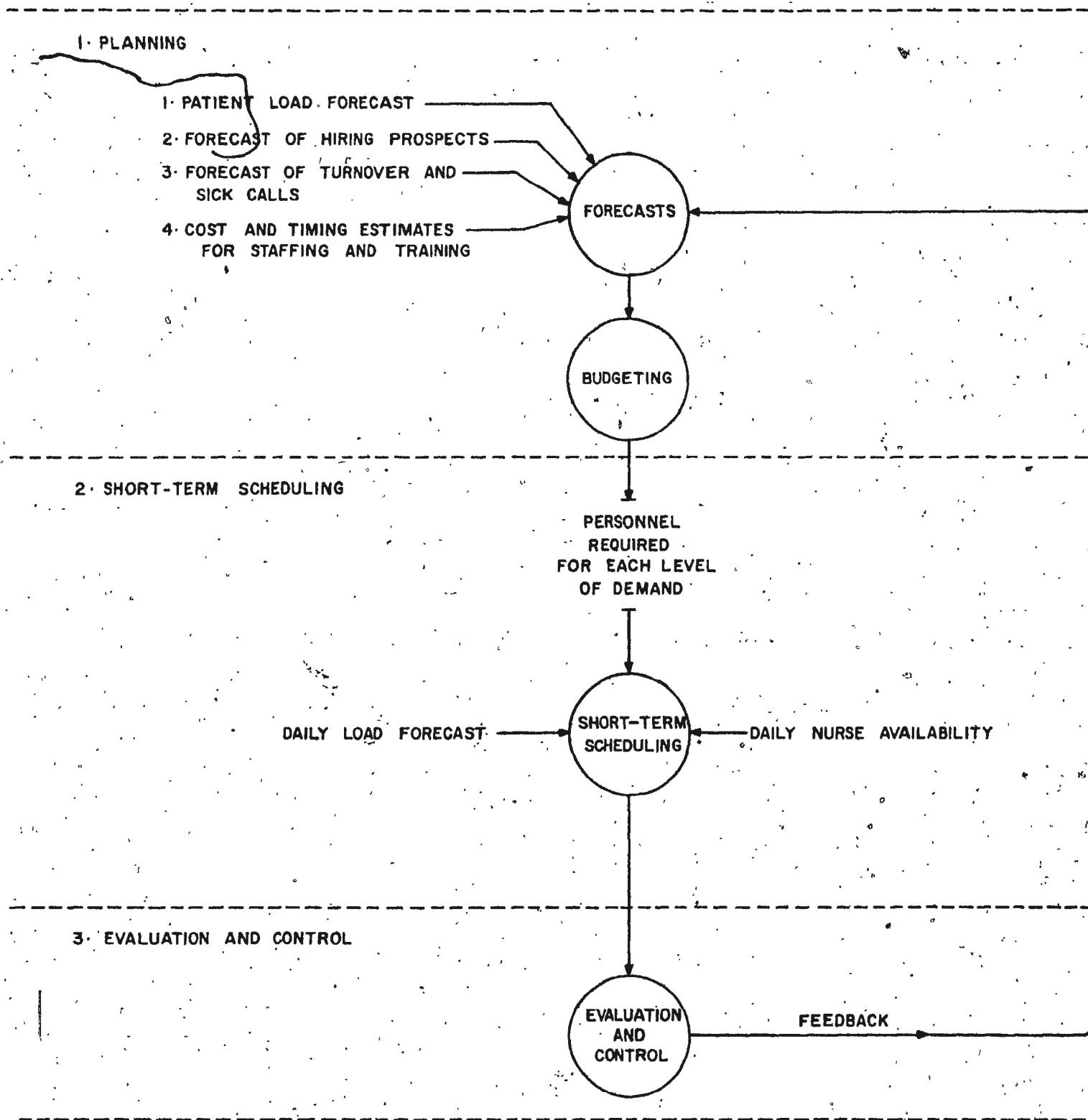


Figure 4. A Total View of Nurse Scheduling Process.

and control. It is assumed here that the forecast and budget have been established and that the personnel required on each unit have been determined. The system is designed so that it can be applied regardless of the procedure the hospital may have adopted for the first problem area. Evaluation and control is primarily concerned with short-term scheduling.

The system developed in this study contains the following:

- (1) Computerized scheduling of nursing personnel by day and shift subject to constraints,
- (2) A methodology which predicts workload on a daily basis for each unit,
- (3) A method for adjusting available nursing personnel among units to match forecasted workload demands and,
- (4) Management reports to evaluate the schedules produced.

### 1.3 PRESENT APPROACHES TO SCHEDULING

There are three basic approaches to scheduling:

- (1) The Traditional approach where the head nurse works out a new schedule for each scheduling period in a trial and error fashion.
- (2) The Cyclical approach which establishes a work pattern that can be repeated period after period.
- (3) The Mathematical approach which works out a schedule that conforms to a list of constraints.

Present scheduling methods use one or a combination of these approaches as a basis for the solution of the scheduling problem. The methods are manual or computer-based. The mathematical approach which involves linear programming, stochastic programming or simulation, usually uses the computer to aid in the solution. In addition to the basic scheduling procedure, a manual or computerized allocation procedure is normally used for daily adjustment of staff to meet workload.



#### 1.4 LACK IN PRESENT APPROACHES TO SCHEDULING

The present approaches to nurse scheduling have several weaknesses that make their application in the hospital environment difficult. The traditional method of scheduling has the associated problems of uneven distribution of shifts, time consuming preparation, lack of pattern and potential bias of head nurses. Mathematical methods are, for the most part, theoretically sound, but lack flexibility to change with changing conditions in the hospital environment. [25] Such methods usually incorporate a mathematical formulation of the constraints imposed by the particular hospital. The number of constraints is so large that it exceeds the limits of a small size computer. Some initial conditions may exist which can create no feasible solution to the mathematical formulation. [51] The solution is usually approximate and final adjustment to the work schedule has to be made by hand.

Current computer scheduling systems in Table 1 are discounted for a number of reasons. The systems lack flexibility to respond quickly to changes in the work schedule. Rigid structure of constraints and input procedures also contribute to difficulty in implementation of such systems. Most computer-based systems have failed because of lack of involvement of the nursing staff in the design process. [34]

Table 1. List of Computer Scheduling Systems.

COMPUTER SYSTEM	REASON DISCOUNTED
1. Scheduling Nursing Personnel According to Nursing Preference: A Mathematical Approach. [51]	<ul style="list-style-type: none"> <li>- Lack of flexibility.</li> <li>- Input difficult.</li> <li>- 20 - 30% solutions not feasible.</li> </ul>
2. A Nurse Scheduling and Allocation System in Operation. [25]	<ul style="list-style-type: none"> <li>- Rigid constraint structure.</li> </ul>
3. Nurse Staffing with a Data Processing System. [8]	<ul style="list-style-type: none"> <li>- Input difficult.</li> <li>- Lack of flexibility.</li> </ul>
4. Scheduling of Student Nurses with the Aid of a Computer. [36]	<ul style="list-style-type: none"> <li>- Limited to students.</li> <li>- Lack of flexibility.</li> </ul>
5. Cyclic Scheduling. [34]	<ul style="list-style-type: none"> <li>- Lack of flexibility.</li> </ul>

The cyclical approach to scheduling is chosen in this study as the basis of the scheduling system because of its numerous advantages. More details on cyclical scheduling are included in Appendix E. These advantages outweigh its one disadvantage - lack of flexibility. This is offset here by employment of a computer method which gives speed and flexibility to the system. Float<sup>7</sup> nurses, part-time staff and personnel substitution are used to further increase flexibility to accommodate unexpected changes in the work schedule. Cyclical scheduling has the following advantages:  
[19, 39]

1. Nurses<sup>8</sup> know their hours in advance and can schedule recreational activities accordingly.
2. Fairer distribution of shifts among all nursing personnel.
3. Gives equal treatment to all personnel.
4. Balances work and rest periods.
5. Less time spent on the technical details of scheduling.
6. Better utilization of personnel.
7. Promotes morale.

---

<sup>7</sup> Nurses who have agreed to move from unit to unit on request.

<sup>8</sup> Includes registered nurses, nurse interns and nursing assistants.

## 1.5 OBJECTIVES

The basic objective of this system is to provide the administration of the hospital with a methodology for the scheduling and allocation of available nursing staff throughout the hospital. The specific objectives of the nurse scheduling system are to:

- (1) Provide work schedules that distribute shifts equally.
- (2) Project work schedules over a predetermined period of time.
- (3) Reduce the time spent by the head nurse on staffing.
- (4) Avoid overstaffing and provide a uniform level of patient care.
- (5) Provide flexibility to meet changing needs on the patient unit.

## 1.6 REQUIREMENTS

This study requires the development of a scheduling system to meet stated objectives and solve the existing problems. The design of the system should involve the participation of the nursing staff within the hospital. Each component of the system need be independent of the others and its use entirely optional. Individual components ought to be completely user-oriented and require no expertise to use. Any computer program written must be general enough so that no modifications are necessary to suit policy or contract changes. This means that a heuristic scheduling method which accepts the constraints imposed by the user has to be designed.

## 2. GENERAL DESCRIPTION OF THE SYSTEM

A computer-aided scheduling system is developed which produces work schedules for the nursing staff. Work schedules are selected, assembled and projected to meet hospital and contract requirements. Daily allocation of staff is based on the workload prediction for each unit. The scheduling system consists of the four basic components:

- (1) Work pattern selector.
- (2) Work schedule assembler.
- (3) Work schedule projector.
- (4) Workload prediction and allocation of staff.

The diagram shown in Figure 5 shows the arrangement of the four components, together with the inputs and outputs of each. The description will now proceed with the development of the logic of each component of the system.

Input

1. Coverage by shift
2. Available Staff
3. Weekend Policy

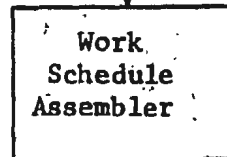
1. Category of Staff
2. Pattern length
3. Constraints

1. File and calendar information
2. Name and Status

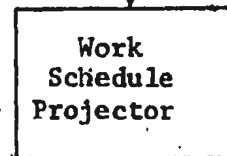
1. Workload Parameters
2. Patient Mix
3. Float Staff List
4. Substitution List
5. Part-time Staff List



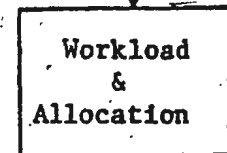
Work Patterns



Work Schedules



Unit Schedule

Output

1. Required coverage
2. Required Personnel
2. Coverage with Patterns

1. Evaluation of Schedule
2. Total coverage

1. Individual Schedule

1. Allocation Report for Float Employees
2. Required vs. Actual Staffing

Figure 5. Components of Scheduling System.



## 2.1 WORK PATTERN SELECTOR

This component of the system selects cyclical work patterns that can be repeated indefinitely for a group of nurses. A work pattern is the way in which days off are planned in a given period of time. There are an infinite number of patterns that can be developed, depending upon the particular hospital's requirements. For example, a typical four-week pattern is shown in Figure 6.

Pattern No.	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	00	00	00	00

Figure 6. Typical Work Pattern. 0 = Day off; Blank = Workday

The pattern is cyclical if at the end of the period, (in the example four-weeks), the pattern is used over again. Cycles can be established for any number of weeks. A three-week pattern repeats every three weeks; a four-week pattern repeats every four weeks.

The length of the pattern chosen will depend upon one of the following two situations [21]:

- A. The pattern may be developed for a small number of staff, for example, the registered nurses on one unit. The length of the pattern in weeks should be equal to the number of required staff to give the necessary coverage. Thus, if five staff are required to give the coverage, the pattern should be five weeks in length. Long pattern lengths, for example, a fourteen-week pattern, can be adjusted by dividing by a factor of two to leave a more reasonable pattern length of seven weeks.

B. . The pattern may be developed for the entire nursing department which involves a large number of personnel. One pattern may be developed for all personnel.

In this study, patterns are developed, using the first method, for each category of staff on the unit. This allows the pattern to be tailored to meet the preferences of the staff on the unit. Healy's [19] method is used to select patterns for the unit. The output from this component of the system is a list of patterns which give the most even coverage for the week.

## 2.2 WORK SCHEDULE ASSEMBLER

This component of the system assembles the work patterns into work schedules for the different categories of personnel. The preferences of the staff are obtained by interviews and the data used for interaction with the computer. The pattern is filled with the day, evening and night shifts, and then expanded for the pattern length. For example, a four-week pattern is expanded for four employees as shown in Figure 7.

Employee	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	EEOODDD	DDDDOOD	DDDDDOO	OOEEEEEE
2	OOEEEEEE	EEOODDD	DDDDOOD	DDDDDOO
3	DDDDDOO	OOEEEEEE	EEOODDD	DDDDOOD
4	DDDDOOD	DDDDDOO	OOEEEEEE	EEOODDD
	D	2222212	2222212	2222212
	E	1111111	1111111	1111111
	N	0000000	0000000	0000000

Where D = Day Shift   E = Evening Shift   N = Night Shift   Zero = 0

Figure 7. Expanded Work Pattern for Four Employees.

The coverage for each shift is given below the schedule. This component is very flexible and permits changes to be made in the schedule until a satisfactory result is achieved. Interaction with a computer enables any modifications to be done quickly. Provisions are made to assemble a complete work schedule for up to three categories of personnel. Each category contains regular, permanent or part-time personnel.

A full report is available on each work schedule produced so that the suitability of the schedule is evaluated by the user. Various parameters are listed to assist the user to judge the quality of the schedule.

### 2.3 WORK SCHEDULE PROJECTOR

This component allows the user to project the work schedule for the unit or the individual over a predetermined period of time.

The time period varies from six weeks to one year. Work schedules for the unit are stored and updated to include class days, vacation, sickness, etc.

The work schedule for the unit includes the daily coverage for each shift. This enables nursing administration to assess the total staffing situation in the hospital daily and arrange adequate staff to meet shortages. In this way, work schedules are monitored and changed so that a uniform level of care is maintained throughout the hospital.

### 2.4 WORKLOAD AND ALLOCATION

This component of the system consists of two parts:

- (1) Workload prediction ,
- (2) Allocation .

### 2.4.1 Workload Prediction

More than seventeen methods are found to exist in the literature describing the measurement of workload on the nursing unit. [25] In this study patients are classified into three classes ( $N_1$ ,  $N_2$ ,  $N_3$ ) since each class requires a different amount of nursing care. Indirect care is considered to be constant for any number of patients on the unit. [52] A workload index (WLI) in terms of nursing hours per 8-hour shift is calculated for each unit, considering the indirect and direct care requirements of the nursing unit. The equation is stated as follows:

$$WLI = I + a_1N_1 + a_2N_2 + a_3N_3$$

Where WLI = Workload index

$I$  = hours of indirect care

$a_1$  = hours of direct care required by Class I patient

$a_2$  = hours of direct care required by Class II patient

$a_3$  = hours of direct care required by Class III patient

$N_1$  = number of Class I patients

$N_2$  = number of Class II patients

$N_3$  = number of Class III patients

In order to apply this formula it is necessary to estimate the parameters ( $I$ ,  $a_1$ ,  $a_2$ ,  $a_3$ ) for each unit on which it is to be used. Various methods such as continuous time study, work sampling or a subjective approach can be used to determine these. Here a new and simple form of time study to estimate these parameters is designed which gives the desired results and requires no special help for analysis. The time study data is collected by the nurses on the unit. The details of the time study are discussed in a later chapter.

Also, the number of patients ( $N_1, N_2, N_3$ ) in each classification have to be determined. Standard patient classification forms as suggested by the Hospital Systems Improvement Program<sup>[22]</sup> of the University of Michigan Hospital are used to classify the patients.

#### 2.4.2 Allocation

The allocation of nurses among units is based on the predicted workload index for each unit. Floats, part-time staff and personnel substitution give flexibility to the work schedule so that sick leave, annual leave and requests for days off are covered without disrupting the existing work pattern. Before each shift, all float nurses report to the central scheduling office for daily assignments. Assignment to a certain unit depends on the patient need for the unit. This is reflected in the workload index for the unit which forecast the number of nursing hours of care required for the shift. Each float nurse is given a unit as a home base but must float to other units when requested. Float nurses are more versatile and experienced than regular staff. The float nurses are available to a unit when the basic core of regular staff for the unit is inadequate to meet the requirements for patient care.

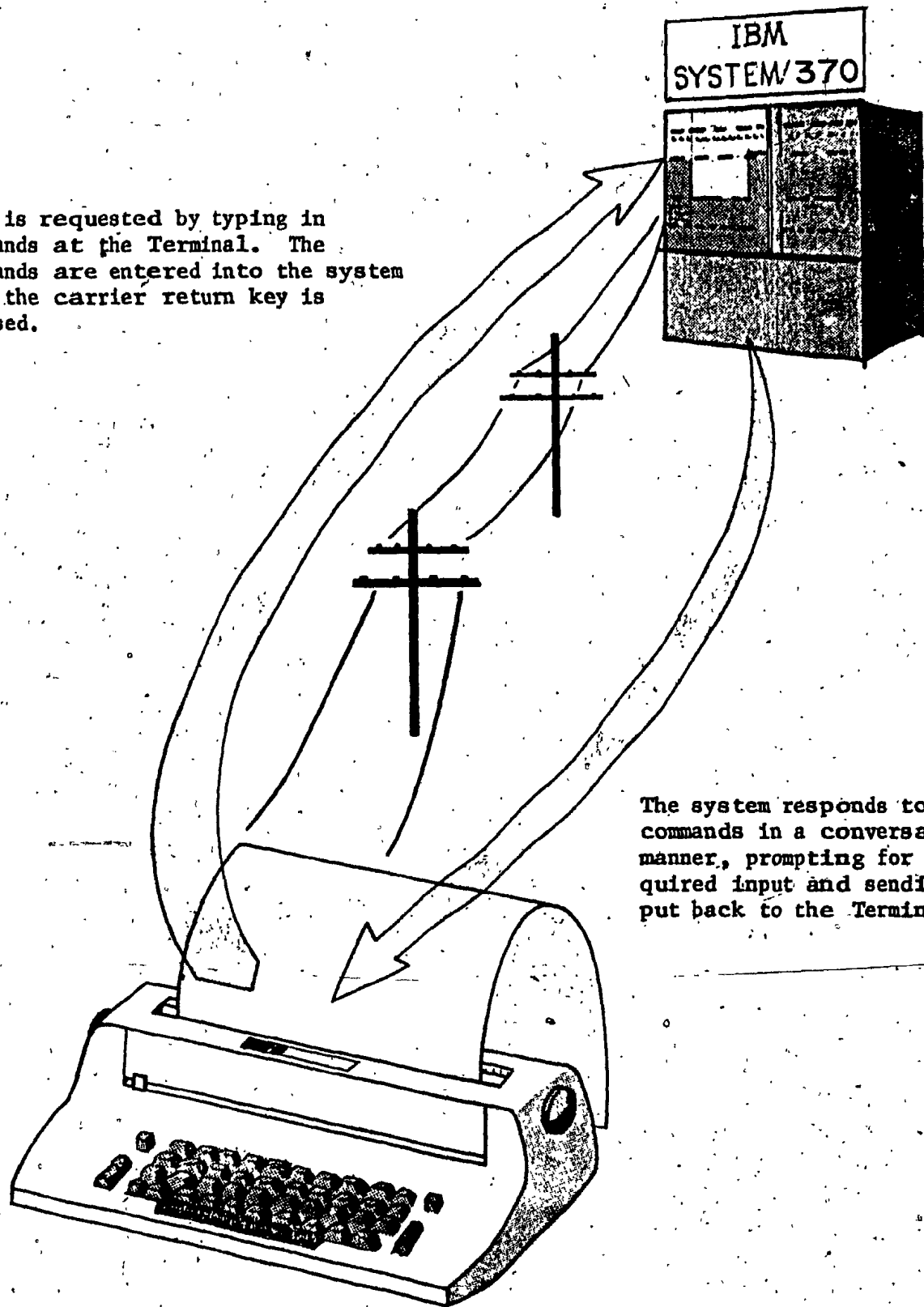
### 3. COMPONENTS OF THE SYSTEM

This chapter describes in detail the logic of each component of the system together with its inputs and outputs. Three of the four components in the scheduling system are computerized; the fourth operates in the manual mode. To use the computerized components, the user communicates via a computer terminal over a telephone line to a remote computer installation. An example of a computer terminal is shown in Figure 8. All computer inputs and outputs are sent or received by the terminal.

One computer program is written for each of the three automated components. The programs which are written in Code and Go Fortran language for the IBM 370 computer are listed in Appendix A. The programs are conversational and prompt the user to answer specific questions. Each program explains its use and limitations in an information sheet which can be printed at the option of the user.

Each component of the system is now discussed in terms of (i) logic, (ii) inputs, and (iii) outputs. Flowcharts of the logic of each component are given and the discussion centers around each flowchart. Sample outputs are provided to illustrate the information available from each component.

Work is requested by typing in commands at the Terminal. The commands are entered into the system when the carrier return key is pressed.



The system responds to the commands in a conversational manner, prompting for required input and sending output back to the Terminal.

Figure 8. Computer Terminal.



### 3.1 WORK PATTERN SELECTOR

The purpose of this component is to select repeatable work patterns.

#### 3.1.1 Logic

The flowchart of the logic of the work pattern selector is given in Figure 9. The user considers the weekday coverage first. In response to questions asked by the computer through the terminal, this is typed in. The number of available staff who work set patterns excluding the head nurse and team leader is input. Any reduction in staff on weekends is also considered. Selected work patterns for three categories of staff are then printed.

#### 3.1.2 Inputs

The inputs to the program are:

- (1) Coverage by shift,
- (2) Available staff,
- (3) Weekend policy.

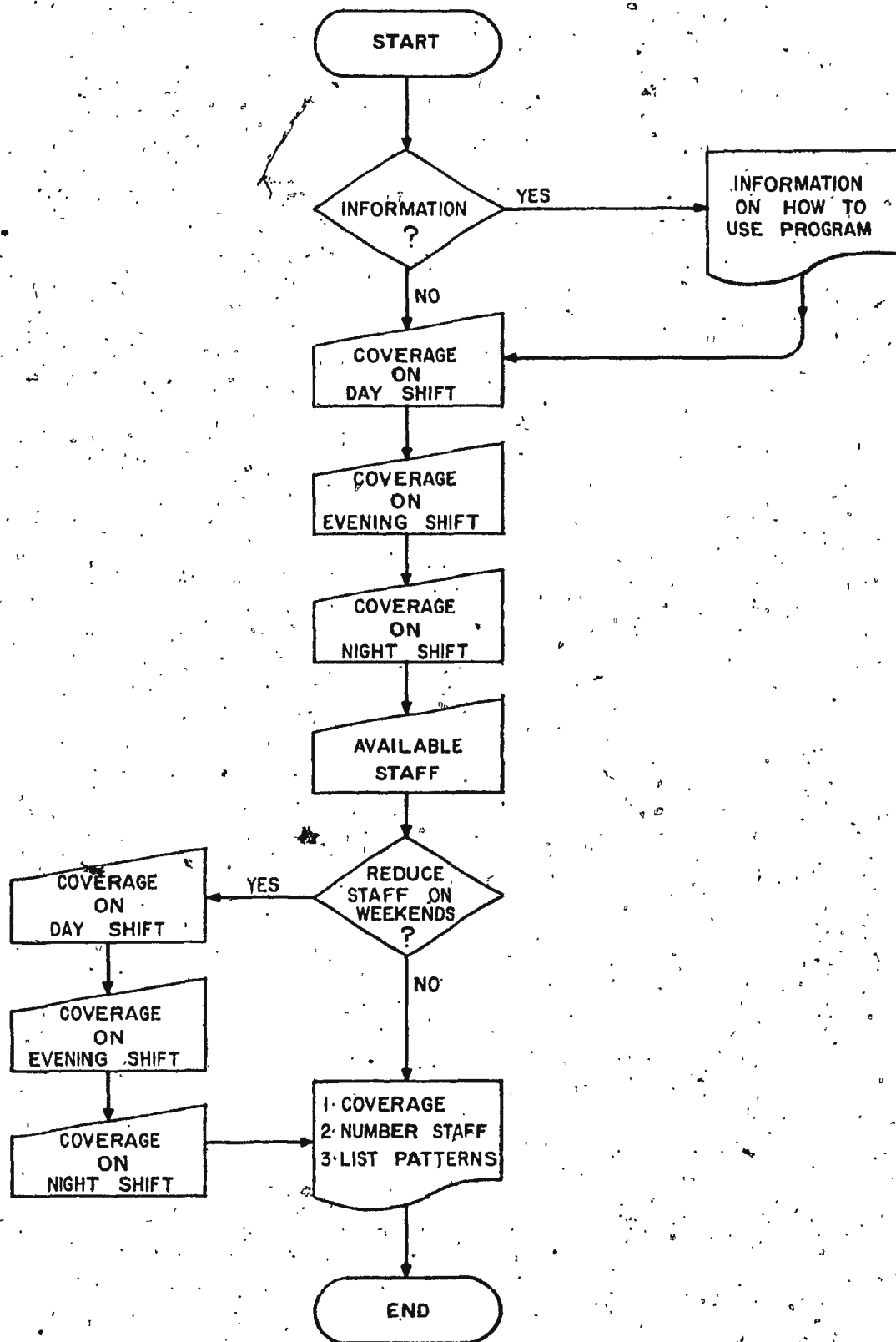


Figure 9. Flowchart of Work Pattern Selector.

Coverage by shift: A certain number of each type of personnel is required on each shift to provide the necessary coverage. That is, a certain number of registered nurses, nurse interns and nursing assistants are required on the day, evening and night shifts. Past experience and subjective judgement usually dictate the personnel mix needed to cover the shifts. Hospital policy indicates that at least one professional staff member must be present on each shift.

Available staff: The available staff consists of the nursing staff attached to the unit on a permanent basis to provide patient care. The size of this work force is predetermined from past history or some objective method such as work sampling.

Weekend policy: A constant coverage of staff on each shift is normally maintained during the week, with a slight reduction on weekends. This is because hospital support services operate at minimal levels during weekends. Reductions in staff amount to about twenty per cent, depending on the particular hospital policy.

### 3.1.3 Outputs

The output from the work schedule selector contains four items:

- (1) Required coverage,
- (2) Required personnel,
- (3) Work patterns,
- (4) Coverage with patterns.

Required coverage: This is an 'echo' print of the coverage that was input for checking purposes. An example is shown in Figure 10.

Weekdays					Weekends				
	RN	NI	NA	Total		RN	NI	NA	Total
D	3	1	1	5	D	2	1	1	4
E	0	1	1	2	E	0	1	1	2
N	0	1	1	2	N	0	1	1	2
Total	3	3	3		Total	2	3	3	

Figure 10. Example of Required Coverage Output.

Required personnel: A list of the number of staff needed, available and selected is printed as output. An example is shown in Figure 11. The number of personnel needed is calculated to give the required coverage. The number of personnel available is input from records. The number of personnel selected for use corresponds to

the available number of staff since this is the number of employees permanently assigned to the unit. If the available staff is inadequate, then more staff need to be provided so that the required coverage is given.

	Needed	Available	Selected
RN	4	4	4
NI	4	3	3
NA	4	3	3

Figure 11. Example of Required Personnel Output.

Work patterns: The patterns are selected based on the selected number of personnel in each category. A typical list of four-week patterns is shown in Figure 12. A five-week pattern is selected for five personnel; a six-week pattern is selected for six personnel and so on. A list of patterns is printed for each category of personnel.

Pattern No.	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	00	00	00	00
2	00	00	00	00
3	00	00	00	00

Figure 12. List of Four Week Patterns Selected.

Coverage with patterns: This is printed for each pattern listed in each category. The exact coverage for each day of the week can easily be seen from the illustration in Figure 13. This aids the user in choosing a pattern which gives the weekly coverage desired. The choice of any one of these patterns is optional.

Pattern No.	M	T	W	T	F	S	S
1	3	2	3	3	3	3	3
2	3	3	3	2	3	3	3
3	3	3	3	3	3	2	3

Figure 13. Daily Coverage with Patterns Selected.

### 3.2 WORK SCHEDULE ASSEMBLER

The purpose of this component is to build up a work schedule for a unit. The user interacts with the computer until a satisfactory schedule is produced. The component requires that the user be completely familiar with hospital policy, contracts and constraints.

#### 3.2.1 Logic

The following discussion refers to the flowchart of the work schedule assembler given in Figure 14. The component has the capacity and the flexibility to assemble a schedule for three different categories of personnel. The program proceeds to consider one category of staff at a time. Each category of staff may contain regular, part-time, or permanent shift staff. Changes can be made in the schedule during the build-up within each category or after the complete schedule is assembled. Reports are available on request so that the user can evaluate the schedule produced.

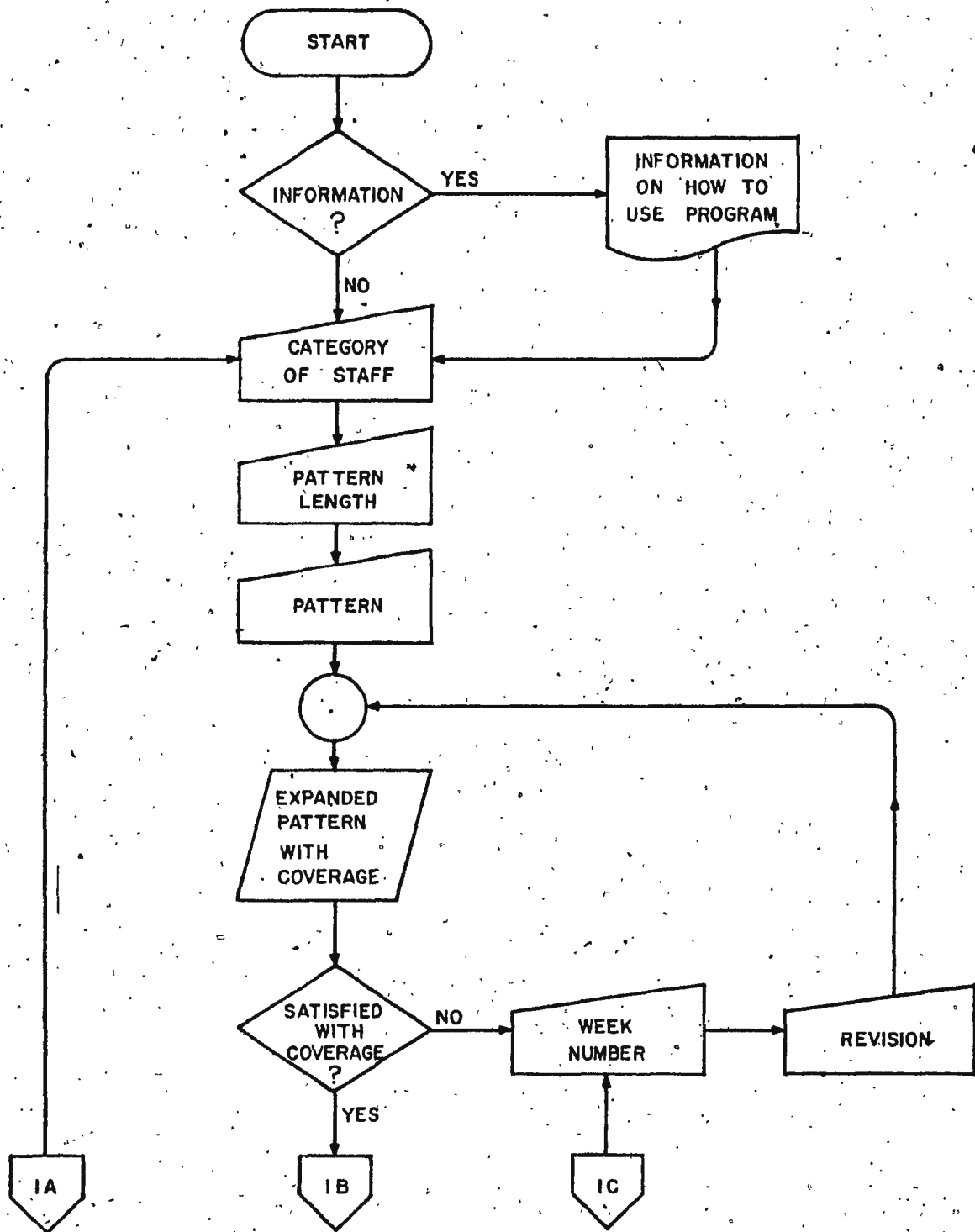
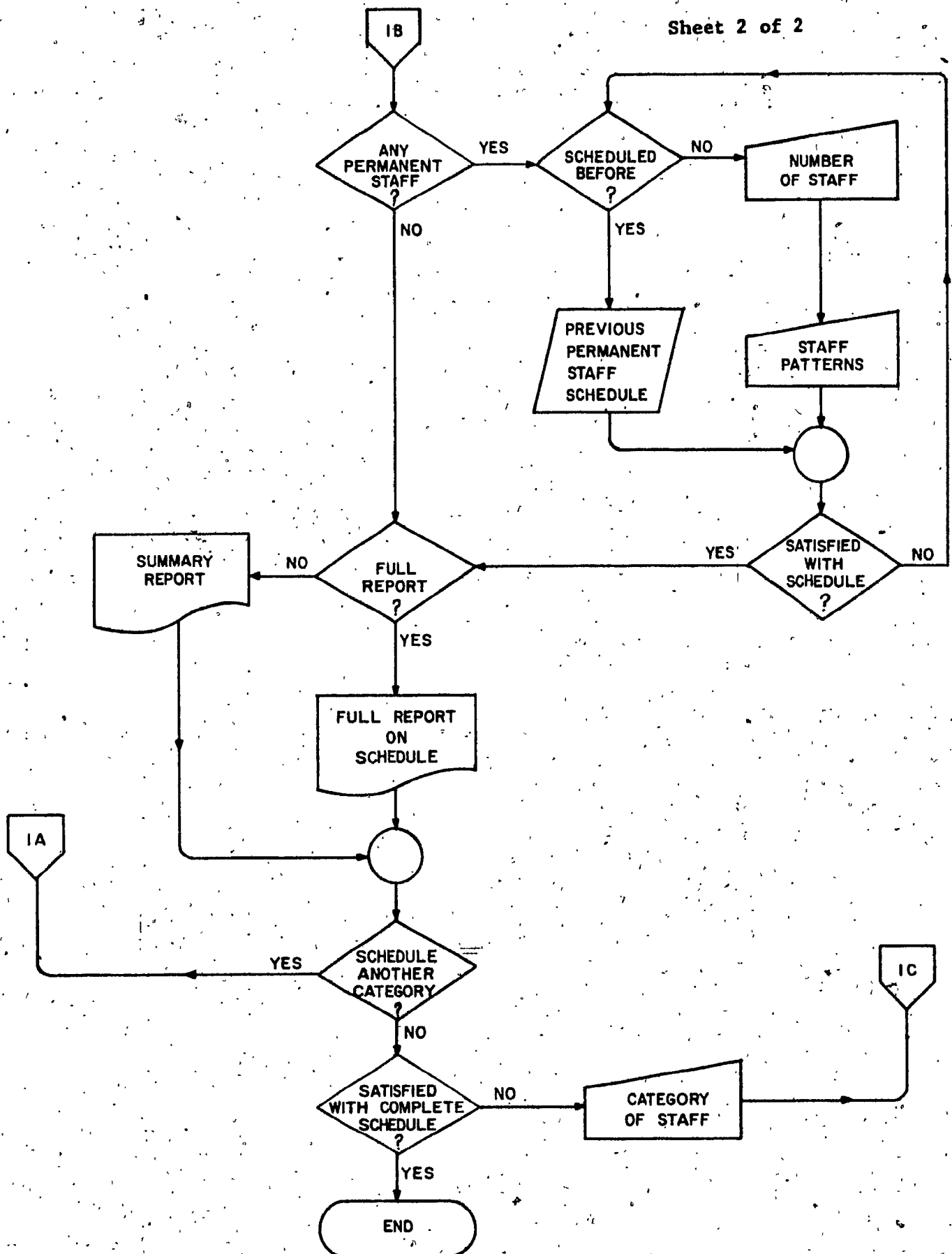


Figure 14. Flowchart of Work Schedule Assembler.





### 3.2.2 Inputs

The inputs to the work schedule assembler are:

- (1) Category of staff,
- (2) Pattern length,
- (3) Work pattern,
- (4) Constraints,

Category of staff: This refers to the skill class of the personnel being scheduled. In this study, three categories of staff are scheduled - registered nurses, nurse interns and nursing assistants.

Pattern length: The pattern length in weeks depends upon the number of personnel being scheduled. The pattern length varies from two up to seven weeks.

Work pattern: The work pattern for each staff category is input with shifts filled in. The initial pattern for each category is based upon interviews with members of that skill class so that preferences with regards to work stretches, rotation and days off are determined.

Constraints: The constraints are input in the form of subjective judgement by the user. The user is aware of the nurses' preferences, hospital policies and contract restrictions. The experience of the user with the constraints initiates a critical evaluation of each schedule so that a high grade schedule is produced.

### 3.2.3 Outputs

The output reports from the work schedule assembler contain:-

- (1) Work schedules,
- (2) Evaluation of schedule,
- (3) Total coverage.

A full report from the work schedule assembler (see Figure 15) gives the above outputs. Aspects of the full report are now discussed.

\*\*\*\*\*

## FULL REPORT FOR RN S

=====

## SCHEDULE FOR 1 PERMANENT SHIFT STAFF

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	EEEXXEE	EEEEEXX	EEEXXEE	EEEEEXX
D	0000000	0000000	0000000	0000000
E	1110011	1111100	1110011	1111100
N	0000000	0000000	0000000	0000000

## SHIFT SCHEDULE FOR 4 RN S

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	NNXXDDD	DDDDXXD	DDDDXXD	XXNNNNN
2	XXNNNNN	NNXXDDD	DDDDXXD	DDDDXXD
3	DDDDXXD	XXNNNNN	NNXXDDD	DDDDXXD
4	DDDDXXD	DDDDXXD	XXNNNNN	NNXXDDD
D	222212	222212	222212	222212
E	0000000	0000000	0000000	0000000
N	1111111	1111111	1111111	1111111

## TOTAL COVERAGE RN S AND SHIFT STAFF

	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
D	222212	222212	222212	222212
E	1110011	1111100	1110011	1111100
N	1111111	1111111	1111111	1111111

## FULL REPORT ON SCHEDULE FOR RN S

MINIMUM WORK STRETCH = 6

MAXIMUM WORK STRETCH = 7

TOTAL DAY SHIFTS = 13

TOTAL EVENING SHIFTS = 0

TOTAL NIGHT SHIFTS = 7

TOTAL NUMBER OF WORKDAYS = 20

NUMBER OF SPLIT DAYS OFF = 0

NUMBER OF WEEKENDS OFF IN 4 = 1

## VIOLATIONS

\*\*\*\*\*

NUMBER OF TIMES EVENING OR NIGHT SHIFT BEFORE WEEKEND OFF = 0

NUMBER OF TIMES EVENING-DAY SHIFT = 0

1 of

N 1111111 1111111 1111111 111 11  
TOTAL COVERAGE RN S AND SHIFT STAFF  
-----

MTWTFSS MTWTFSS MTWTFSS MTWTFSS  
D 2222212 2222212 2222212 2222212  
E 1110011 1111100 1110011 1111100  
N 1111111 1111111 1111111 1111111

FULL REPORT ON SCHEDULE FOR RN S  
-----

MINIMUM WORK STRETCH = 6  
MAXIMUM WORK STRETCH = 7  
TOTAL DAY SHIFTS = 13  
TOTAL EVENING SHIFTS = 0  
TOTAL NIGHT SHIFTS = 7  
TOTAL NUMBER OF WORKDAYS = 20  
NUMBER OF SPLIT DAYS OFF = 0  
NUMBER OF WEEKENDS OFF IN 4 = 1

VIOLATIONS  
\*\*\*\*\*

NUMBER OF TIMES EVENING OR NIGHT SHIFT BEFORE WEEKEND OFF = 0  
NUMBER OF TIMES EVENING-DAY SHIFT = 0  
NUMBER OF TIMES EVENING-NIGHT SHIFT = 0  
NUMBER OF TIMES NIGHT-DAY SHIFT = 0

TOTAL COVERAGE FOR 1 CATEGORY OF STAFF  
-----

MTWTFSS MTWTFSS MTWTFSS MTWTFSS  
D 2222212 2222212 2222212 2222212  
E 1110011 1111100 1110011 1111100  
N 1111111 1111111 1111111 1111111

END OF RUN 1  
-----

\*\*\*\*\*

Figure 15. A Sample Full Report on Schedule.

Work schedules: Work schedules for both the regular and permanent shift staff with the coverage for each is printed. Part-time staff are included with permanent shift staff. Days off and work shifts are shown.

Evaluation of schedule: Important variables are listed so that the schedule printed for the regular staff may be evaluated. These variables aid the user in determining the fairness of the work schedule. Items listed under "Violations" are those which are generally considered to be undesirable by the nursing staff. The criteria used to evaluate the work schedule contain elements which are of concern when developing a schedule.

Total coverage: This part of the report gives the total coverage of the number of categories scheduled to date. The coverage of each category is added together to give a total figure for each shift. This aids the user in monitoring the coverage as each new category of staff is added to the schedule. In lieu of a full report, a summary report as shown in Figure 16 is printed. This report just totals the coverage of the number of categories of staff scheduled.

\*\*\*\*\*SUMMARY REPORT\*\*\*\*\*

TOTAL COVERAGE FOR 1 CATEGORY OF STAFF

```

MTWTFSS MTWTFSS MTWTFSS MTWTFSS
D 222212 222212 222212 222212
E 1110011 1111100 1110011 1111100
N 1111111 1111111 1111111 1111111

```

END OF RUN 2

\*\*\*\*\*

the schedule.

These variables aid the user in determining the fairness of the work schedule. Items listed under "Violations" are those which are generally considered to be undesirable by the nursing staff. The criteria used to evaluate the work schedule contain elements which are of concern when developing a schedule.

Total coverage: This part of the report gives the total coverage of the number of categories scheduled to date. The coverage of each category is added together to give a total figure for each shift. This aids the user in monitoring the coverage as each new category of staff is added to the schedule. In lieu of a full report, a summary report as shown in Figure 16 is printed. This report just totals the coverage of the number of categories of staff scheduled.

\*\*\*\*\*SUMMARY REPORT\*\*\*\*\*

TOTAL COVERAGE FOR 1 CATEGORY OF STAFF

MTWTFSS MTWTFSS MTWTFSS MTWTFSS  
D 2222212 2222212 2222212 2222212  
E 1110011 1111100 1110011 1111100  
N 1111111 1111111 1111111 1111111

END OF RUN 2

\*\*\*\*\*

Figure 16. A Sample Summary Report on Schedule.



### 3.3 WORK SCHEDULE PROJECTOR

The purpose of the work schedule projector is to print the individual and unit schedule for a planned period of time.

#### 3.3.1 Logic

The logic of this component is shown in Figure 17. Initial calendar and file information is input to the program. The calendar information is used mainly to print headings in the output reports. File information is required so that an old schedule which has been stored by the computer can be retrieved and updated. Optional printout of the individual's schedule is facilitated during input. The ability to project both schedules up to one year allows annual leave and holidays to be fitted into the schedule.

The update feature of this component enables the user to modify an old schedule because of unforeseen changes in the schedule due to sickness, absenteeism, etc. Automatic storage of each new unit schedule is provided once the file number has been specified. Retrieval of an old unit schedule is simply made by specifying the file number and the number of employees contained in the file.



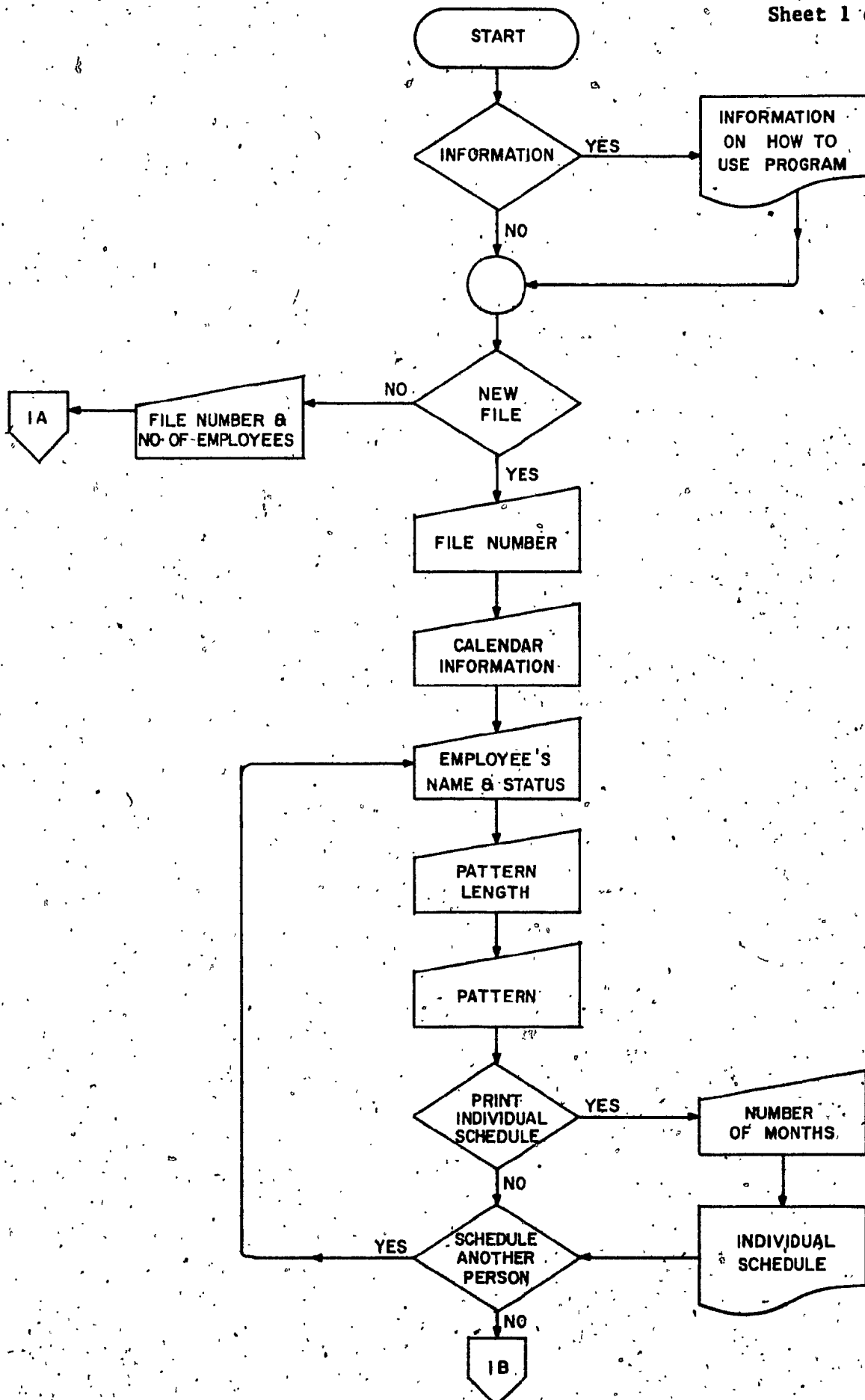
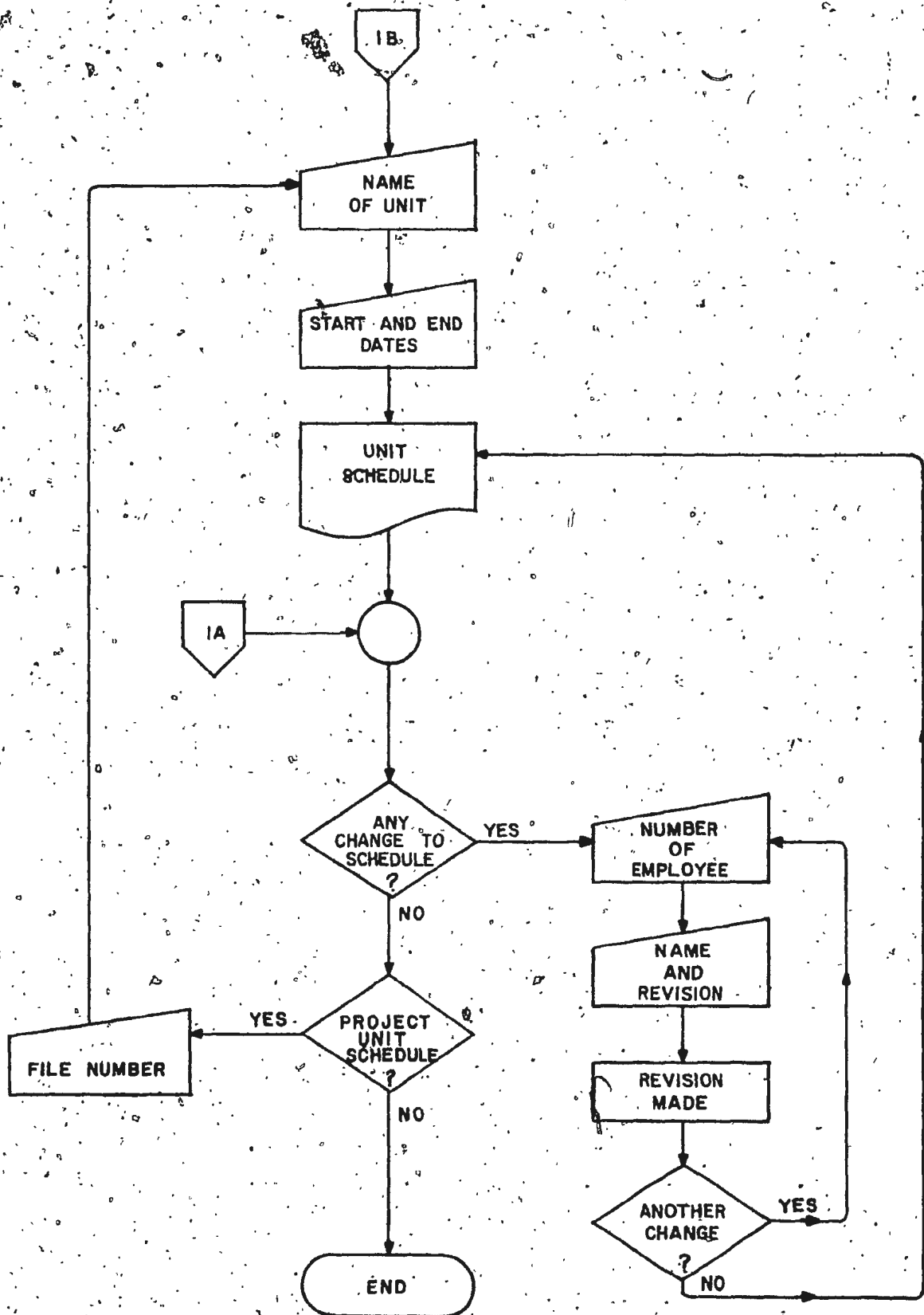


Figure 17. Flowchart of Work Pattern Projector.



### 3.3.2 Inputs

The inputs to the work schedule projector are:

- (1) File and calendar information,
- (2) Name and status,
- (3) Work schedules.

File and calendar information: The file number is used to store new unit schedules or to retrieve old unit schedules. The calendar information includes:

- (i) Month, day of month and day of week that the pattern starts,
- (ii) Beginning of the month that the schedule starts,
- (iii) Indication if a leap year,
- (iv) Month, day of month and year schedule ends.

This information is used in the format of the output.

Name and status: The name and status of each employee serves as identification to a particular unit schedule. The employee's first name, last name and working title is input for this purpose.

Work schedules: Each person's schedule is input with day, evening, night shifts and days off.

### 3.3.3 Outputs

The outputs from this component are:

- (1) Individual schedule
- (2) Unit schedule

Individual schedule: The individual schedule is printed in wallet-size with a monthly calendar showing work shifts and days off. The format for this is shown in Figure 18. This kind of personalized schedule helps the individual know her time schedule in advance and makes her feel part of a working team. From this point of view, employee relations with administration are improved and a higher morale on the nursing unit is achieved.

```
*****
* SCHEDULE FOR M. ANTLE RN *
*****
```

MAR						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
	E	X	X	N	N	N
10	11	12	13	14	15	16
N	N	N	N	X	X	D
17	18	19	20	21	22	23
D	D	D	D	D	X	X
24	25	26	27	28	29	30
X	D	D	D	D	D	X
31						
X						

Figure 18. Individual Schedule.

Unit schedule: The format of the schedule for the unit is shown in Figure 19. Each employee's name, status, and schedule is listed. The coverage on each shift is shown so that the number of personnel available on each shift can easily be seen. This is used for the daily allocation of staff.

FILE NUMBER = 2

NUMBER OF EMPLOYEES = 13

THE GENERAL HOSPITAL  
SIX WEEK TIME SCHEDULE

DATE: MAR 4 - APR 14 1974

UNIT: NEURO

1 111111 112222 222233 1111  
4567890 1234567 8901234 5678901 1234567 8901234

DAY OF MONTH 1 MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS

NAME STATUS

M. BROWN	HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLE	RN	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN
L. GREENE	RN	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE
I. BARLETT	RN	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX
D. OAKE	RN	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX
P. WISEMAN	RN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD
W. ROSE	NI	NNXXDD	DEEXDD	DDDDDX	XXNNNN	NNXXDD	DEEXDD
T. PARSONS	NI	XXNNNN	NNXXDD	DEEXDD	DDDDDX	XXNNNN	NNXXDD
B. KEATING	NI	DDDDDX	XXNNNN	NNXXDD	DEEXDD	DDDDDX	XXNNNN
C. LAHEY	NI	DEEXDD	DDDDDX	XXNNNN	NNXXDD	DEEXDD	DDDDDX
G. MARSH	NA	EEEXXEE	EEEEEX	EEEXXEE	EEEXXEE	EEEEEX	EEEXXEE
H. PEACOCK	NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEE	XXDDDD
K. FOSTER	NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE
S. GOSSE	NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX
Y. SMITH	WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX

COVERAGE DAY 5575544 5575544 5575544 5575544 5575544 5575544

EVENING 2222233 2223322 2222233 2222233 2223322 2222233

DATE: MAR 4 - APR 14 1974

UNIT: NEURO

		1 111111 112222 222233						11111	
		4567890 1234567 8901234 5678901 1234567 8901234							
DAY OF MONTH		MTWTFSS		MTWTFSS		MTWTFSS		MTWTFSS	
NAME		STATUS							
M. BROWN		HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLER		RN	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	
L. GREENE		RN	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	
I. BARLETT		RN	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	
D. OAKE		RN	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	
P. WISEMAN		RN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	
W. ROSE		NI	NNXXDD	DEEXDD	DDDDDX	XXNNNN	NNXXDD	DEEXDD	
T. PARSONS		NI	XXNNNN	NNXXDD	DEEXDD	DDDDDX	XXNNNN	NNXXDD	
B. KEATING		NI	DDDDDX	XXNNNN	NNXXDD	DEEXDD	DDDDDX	XXNNNN	
C. LAHEY		NI	DEEXDD	DDDDDX	XXNNNN	NNXXDD	DEEXDD	DDDDDX	
G. MARSH		NA	EEEXEE	EEEEEX	EEEXEE	EEEXEE	EEEEEX	EEEXEE	
H. PEACOCK		NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	
K. FOSTER		NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	
S. GOSSE		NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	
Y. SMITH		WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	
COVERAGE		DAY	5575544	5575544	5575544	5575544	5575544	5575544	
		EVENING	222233	222332	222233	222233	222332	222233	
		NIGHT	222222	222222	222222	222222	222222	222222	
CODE:- D=DAY SHIFT E=EVENING SHIFT N=NIGHT SHIFT X=DAY OFF									
S=SICK LEAVE A=ANNUAL LEAVE C=CLASS DAY O=DAY OWED									
T=NURSING DISTRICT R=REQUESTED DAY OFF									

Figure 19. Unit Schedule.

1 of

### 3.4 WORKLOAD AND ALLOCATION

This component predicts workload daily on each unit and allocates staff daily among the nursing units to match the forecasted workload. The aim of this part of the system is to increase nursing productivity or staff utilization. The logic of the component is shown in Figure 20. The component can be divided into two parts:

- (1) Workload,
- (2) Allocation.

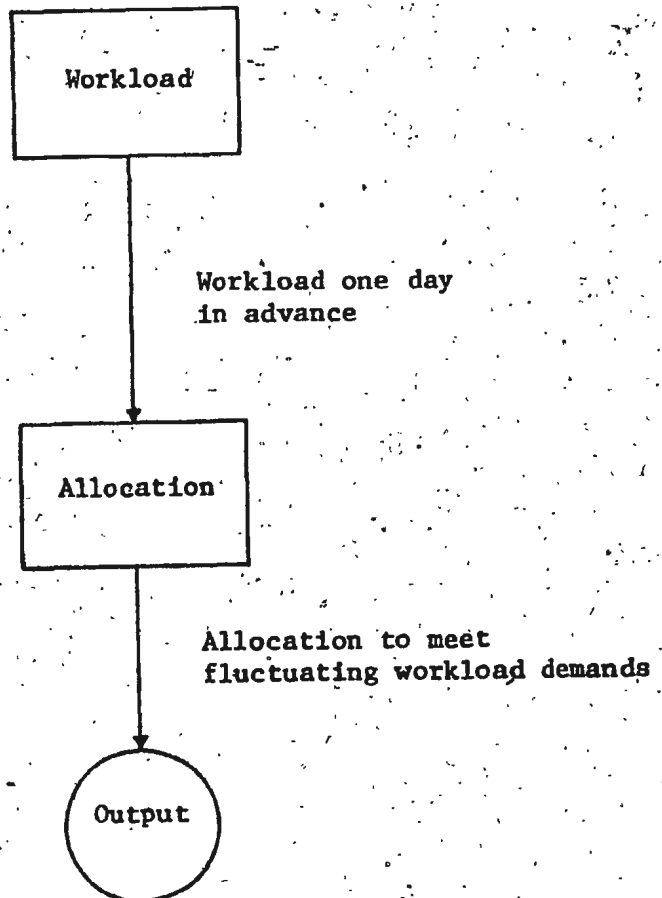
Each part is now described separately.

#### Input

1. Workload Parameters
2. Patient Mix

#### Input

1. Unit Schedules
2. Float Staff List
3. Substitution List
4. Part-time Staff List



1. Allocation Report for Float Employees
2. Graph of Required vs. Actual Staffing



- (1) Workload,  
(2) Allocation.

Each part is now described separately.

Input

1. Workload Parameters
2. Patient Mix

Input

1. Unit Schedules
2. Float Staff List
3. Substitution List
4. Part-time Staff List

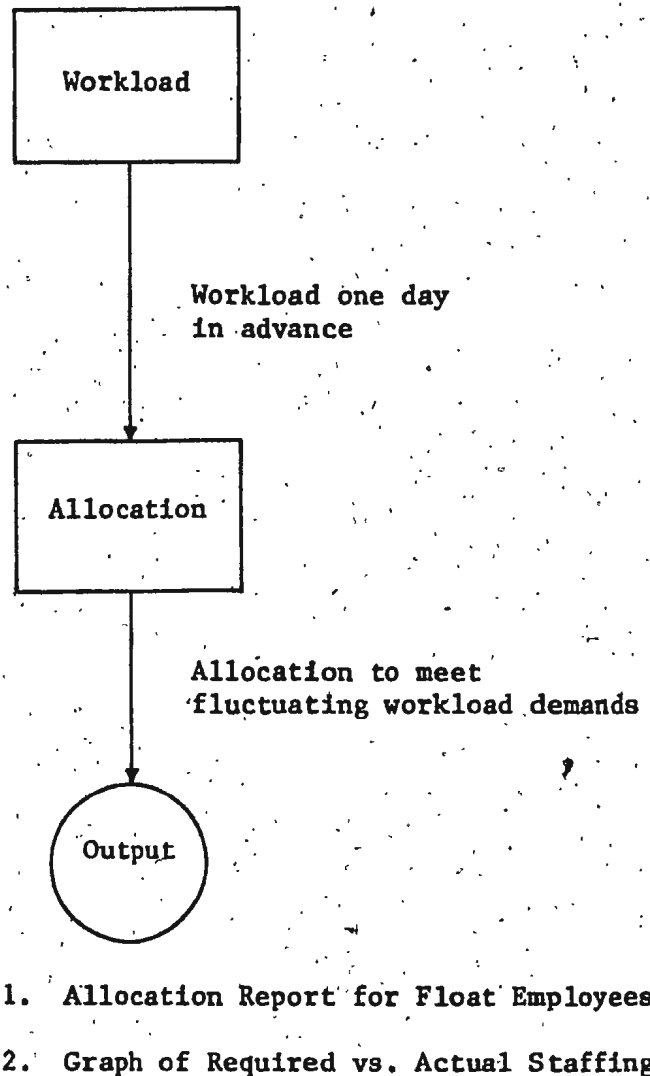


Figure 20. Flowchart of Workload and Allocation Component.

### 3.4.1 Workload

The purpose of this part of the component is to predict workload on each unit one day in advance.

#### 3.4.1.1 Logic

The workload is forecast for the nursing unit using the workload index equation:

$$WLI = I + a_1N_1 + a_2N_2 + a_3N_3$$

Patients are classified daily into three categories and the workload index calculated for each unit. The workload index gives the number of nursing hours of care required for the following day.

#### 3.4.1.2 Inputs

The inputs for the workload part are:

- (1) Workload parameters,
- (2) Patient mix.

Workload parameters: The workload parameters which are obtained by time study are recorded as in Figure 21. The units are numbered from 1.....n. The entries in the table correspond to the parameters in the equation. One file is maintained for each of the three shifts.

SHIFT:	WORKLOAD PARAMETERS			
UNIT	I	$a_1$	$a_2$	$a_3$
1				
2				
3				
⋮				
n				

Figure 21. Workload Parameters Report.

Patient mix: The patient mix is obtained by classifying the patients on the nursing unit using the prescribed forms shown in Appendix B. This gives values for  $N_1$ ,  $N_2$ ,  $N_3$  which are required to calculate the workload index. Patient mix is required daily for continuous operation of the system.

### 3.4.1.3 Output

The output from the workload element is a workload index for each unit in the hospital daily. The required staff is obtained by dividing the WLI by eight. The information is compiled in the following format (Figure 22).

SHIFT: DATE:	PATIENT MIX			WLI	REQUIRED STAFF WLI/8
UNITS	$N_1$	$N_2$	$N_3$		
1					
2					
3					
⋮					
n					

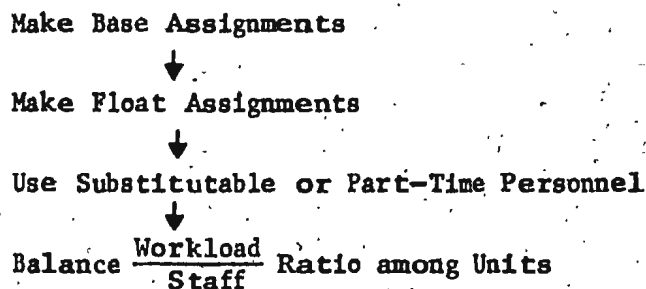
Figure 22. Format of Workload Report.

### 3.4.2 Allocation

The purpose of the allocation element is to assign staff to nursing units to meet fluctuating workload demands.

#### 3.4.2.1 Logic

The allocation procedure consists of a number of priority rules. [25] The logical sequence is:



The allocation sequence can be modified to suit each hospital's needs.

#### 3.4.2.2 Inputs

The inputs to the allocation part are:

- (1) Unit Schedules,
- (2) Float staff list,
- (3) Substitution list,
- (4) Part-time staff list.

Unit schedules: The unit schedules are those printed by the work schedule projector. By scanning the coverage on each unit schedule, one can obtain a total picture of the nursing staff available in the hospital daily.

Float staff list: The float staff list contains the names of nurses who are willing to float to various units. Each float member is interviewed to obtain her preferences of units to which she would like to float. The head nurse approves the list so that only qualified nurses with experience are allowed to be assigned to particular units. The format of the float staff list is shown in Figure 23 where a check mark means the person is willing to float to that unit.

NAME	STATUS	PATIENT UNITS					n
		1	2	3	. . . . .		
Mary Smith	RN	✓		✓			

Figure 23. Format of Float Staff List.

Substitution list: A substitution list is maintained which indicates whether a substitution of one type of personnel for another is feasible. This does not imply that a substitution can be made without loss of efficiency or effectiveness. Thus, when it is not possible to fill a staff requirement with the staff category desired, it may be beneficial to substitute another personnel type for the desired category.

Schematically, the list may have the following form<sup>[27]</sup>

(Figure 24.):

SUBSTITUTABLE PERSONNEL CATEGORY					
	1	2	3	.....	K
Primary	1				
Personnel	2				
Category	3				
.					
.					
.					
.					
.					
K					

Figure 24. Format of Substitution List.

The entries in the diagram are 0 or 1 where:

0 = substitution not feasible

1 = substitution feasible

Part-time staff list: The part-time staff list contains the names of nurses who are willing to work less than five shifts per week. Each part-time person is interviewed to assess her availability to work. A record such as that shown in Figure 25 is kept so that resource development to meet patient needs is easily permitted. Part-time personnel are used primarily to supplement the regular core of staff on each unit.

NAME	STATUS	TELEPHONE NUMBER	SHIFT AVAILABLE						
			M	T	W	T	F	S	S

Figure 25. Format of Part-time Staff List.

The entries in the list are coded where:

- 1 = day shift
- 2 = evening shift
- 3 = night shift

#### 3.4.2.3 Outputs

The outputs from the allocation element are:

- (1) Allocation report for float employees,
- (2) Graph of required versus actual staffing.



Allocation report for float employees: This is a list of all float employees and their assigned units. The report aids in providing continuity of care since the previous day's assignment can easily be seen. The list has the format shown in Figure 26. Entries in the report will be numbers 1.....n where the numbers correspond to patient units.

NAME	STATUS	BASE UNIT	ASSIGNED UNIT															

Figure 26. Allocation Report for Float Employees.

Graph of required vs. actual staffing: This graph is plotted for each unit. The required staff in nursing hours is the workload index. The actual daily staffing is that which is provided daily on the patient unit. The graph is plotted as shown in Figure 27.

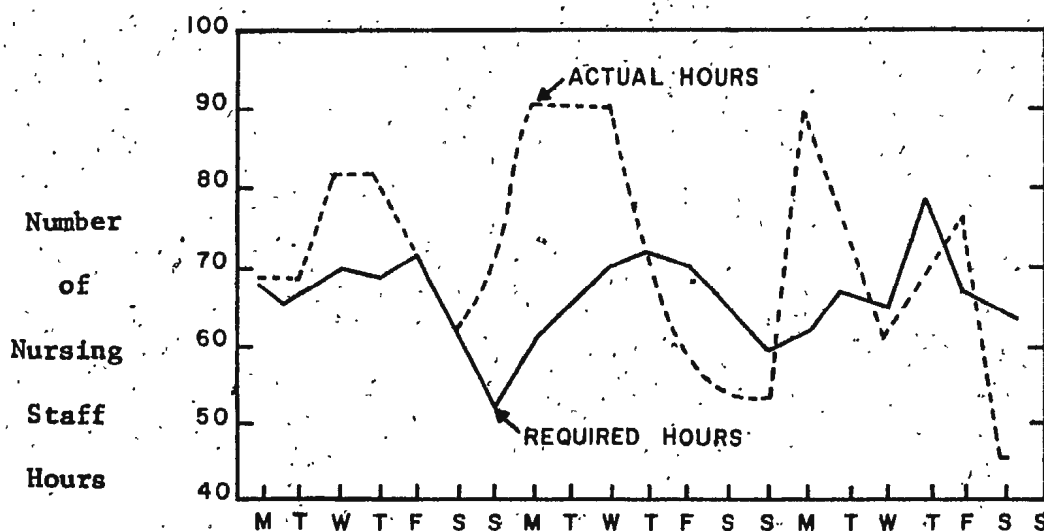


Figure 27. Required Staffing Versus Actual Daily Staffing.

Staff productivity or utilization is measured here. The productivity index for each unit equals the ratio of staff required over actual staff.<sup>[18]</sup> The closer this ratio is to one, then the higher the staff utilization or productivity. Ideally, the required hours of nursing care should coincide with the actual hours provided; that is, the two lines on the graph would be coincident. This mechanism monitors the utilization as both the actual staff and the requirements change. The graph serves as the ultimate test of nursing management efficiency regarding resource deployment.

#### 4. IMPLEMENTATION

##### 4.1 GENERAL

Implementation of the nursing scheduling system depends upon four factors:

1. Centralization of scheduling.
2. Employment of float staff.
3. Alignment of hospital policies.
4. Cooperation of staff and administration.

The following description discusses the need to consider these factors before implementation. An outline is then given for the general procedures for implementation. Specific progress to date in the General Hospital with respect to implementation is also discussed.

##### 4.1.1 Centralization of Scheduling

Centralization of scheduling is necessary to control and allocate nursing staff efficiently within the hospital. For the General Hospital, centralization would result in a cost saving in terms of head nurses' time of \$20,390. A central office monitors the total staffing situation in the hospital daily and supplies personnel to meet unexpected changes in workload. Responsibility for scheduling is clearly defined in the central office. Application of hospital policies in a uniform manner is also easily managed.

#### 4.1.2 Employment of Float Staff

Float nurses are essential to the operation of the nurse scheduling system. Float staff may be acquired from the existing working staff or through hiring and training new staff. A ready supply of floats are available in nurse interns who have completed their training in the hospital. Their familiarity with different units requires less training and orientation.

Incentive has to be provided for a nurse to float. Extra benefits to float members could include higher pay, better shift schedules, etc. Consideration in the form of extra benefits recognizes the skill and additional experience of a float nurse. The value of utilizing float nurses is in their flexibility which permits a lower overall level of staff to be maintained within the hospital.

#### 4.1.3 Alignment of Hospital Policies

To implement this system some basic decisions with respect to hospital policy are required. Any hospital policy that relates to the hiring and scheduling of nursing staff must be examined and streamlined. The centralization of scheduling means that new responsibilities are now placed in the central office and that there is a release of responsibility from the head nurse. Hiring practices have to be changed so that a new staff member is aware of the work pattern on the unit assigned, the advantages of floating and the type of scheduling system in effect.

Policies for float staff have to be developed so that both the float and the scheduling office are aware of their respective responsibilities. Part-time staff policies which allow their schedules to supplement those of the full-time nursing staff have to be developed. Nurse intern policies have to be examined and coordinated so that decisions for scheduling nurse interns can be made at the central office. In total then, policies need be aligned so that responsibilities for scheduling are clearly defined, and application of policies is consistent.

#### 4.1.4 Cooperation of Staff and Administration

A new scheduling system is difficult to implement unless both administration and nurses cooperate fully. Each group has to be aware of the other's plans. Nursing administration must clearly explain to the nurses the benefits of changing to a new scheduling system. Head nurses must be actively involved in the design process so that the system incorporates the ideas and experience of the users. Nursing staff must be kept informed regularly during the development of a new system. Considerable time was spent in this study in interviewing nursing staff to assess the problems associated with current scheduling procedures, obtaining suggestions for improvements and preferences with regards to the working schedule. Nursing personnel were constantly informed of progress. The time spent on this aspect of the design phase was considered worthwhile since it helped implementation at a later stage.

#### 4.2 GENERAL PROCEDURES FOR IMPLEMENTATION

The actual implementation of the system requires two steps:

- (i) Development of the work schedule.
- (ii) Daily operation of allocating staff.

These two procedures are now outlined.

Development of the work schedule: The steps to develop the work schedule for each unit are:

1. Obtain the nursing staff's preferences with respect to:
  - (i) length of work stretch,
  - (ii) split or consecutive days off,
  - (iii) length of weekend,
  - (iv) shift rotation.
2. Consult head nurse to obtain coverage and staff mix for the unit.
3. Use work schedule selector program to obtain list of possible work patterns.
4. Select a suitable work pattern or develop own pattern.
5. Use work schedule assembler program to assemble schedule for the unit.
6. Use work schedule projector program to print schedule or project the schedule.

An example which shows the capabilities of the computer programs to develop a work schedule is shown in Appendix C.

Daily operation of allocating staff: The outline of the procedure for daily operation of the system is:

1. On each patient unit have the head nurse complete the "Patient Classification Form" (Appendix B) and have it delivered to the staffing clerk in the central scheduling office. (May be done around 2:00 p.m. each day.)
2. The staffing clerk classifies all patients for all units using the "Criteria for Patient Classification" form. (Appendix B).
3. The "Daily Adjustment Form" is shown in Figure 28. The assignment of staff is made using the predetermined priority rules.
4. Float staff report to the central scheduling office before each shift and are assigned to a unit.

Shift	Patient Mix			Workload Index WLI	Required Staff WLI/8	Available Staff	Desired Addition or Reduction	Assigned Staff	Productivity Index = $\frac{\text{Required Staff}}{\text{Assigned Staff}}$
Unit	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>						
1									
.									
.									
.									
.									
.									
n									

Figure 28. Daily Adjustment Form.



#### 4.3 IMPLEMENTATION AT THE GENERAL HOSPITAL

Some progress with implementation of the nurse scheduling system has been made at the General Hospital. Computerized scheduling is currently being implemented on one nursing unit with tentative plans to include all units in the hospital. One unit has used the scheduling part of the system for three months. Much of the progress to date has occurred because of the close cooperation of the staff. Nursing approval of the new system is mainly the outcome of their involvement in the design process.

Basically the progress to date can be described under five headings:

1. Time study.
2. Debugging programs.
3. Monitoring of manpower.
4. Estimate of time savings.
5. Cost estimate of computer operation.

The progress in each of these areas is now reported.

#### 4.3.1 Time Study

The purpose of the time study was to determine the parameters ( $I$ ,  $a_1$ ,  $a_2$ ,  $a_3$ ) in the equation:

$$WLI = I + a_1N_1 + a_2N_2 + a_3N_3$$

The time study was designed to let the nurses help in collecting the data. This was done to reduce costs and speed results. Allowing the nurses to conduct the data-taking, encouraged participation in the study and dispelled any fears on their part that their work was being questioned. The quicker the results could be analyzed the more beneficial they would be to the concerned individuals.

Other methods of study [11, 18, 48, 52] were considered and discarded for a number of reasons. Work sampling was found unsuitable primarily because in many cases a nurse would be working for a specific patient but would not be by the bedside. Thus the person doing the work sampling would have to ask the nurse what work she was doing before he could assign a time to a patient. Other problems with work sampling were the limited number of men available to conduct the study (only the author) and the fact the results were needed in a fairly short time.

Continuous time study of either nurses or patients was not attempted because the nurses might misinterpret the intent of the study if they were continually watched and

timed. Also, patient education would have been necessary to explain the person's presence at the bedside. Finally, three different classifications of patients would have to be studied and verified to obtain reasonable estimates of  $a_1, a_2, a_3$ .

Orientation of the new forms and the reason for conducting the time study took about one and a half hours for each unit. Meetings were held with the nursing personnel to explain the mechanics of the study and the reasons for it. Important considerations that were stressed were:

1. That the hospital administration had no pre-conceived conclusion about using the results.
2. That accuracy and honesty in reporting the data were very important.
3. That all nursing staff were expected to participate and by doing so could help in improving the work schedule.
4. The head nurse would be responsible for the conduct of the study.

Consultation with another industrial engineer, the head nurse and nursing administration resulted in the final design of the time study form (Figure 29). The form was designed to facilitate short but accurate entries and occupy a minimum amount of the nurses' time. The form which is printed on

stiff cardboard can be held in the hand and fits easily into the pocket on the nurse's uniform.

The time study forms were introduced and used on two medical-surgical units for one week. The actual data collection was accomplished by having each nurse complete the time study form for each shift worked. The head nurse and team leader were excluded from the time study since their duties were considered mainly supervisory.

WORKING TITLE:		UNIT:		DATE:	
				SHIFT:	
TIME	CODE	TIME	CODE	TIME	CODE
7:50		:10		:30	
:55		:15		:35	
8:00		:20		:40	
:05		:25		:45	
:10		:30		:50	
:15		:35		:55	
:20		:40		11:00	
:25		:45		:05	
:30		:50		:10	
:35		:55		:15	
:40		10:00		:20	
:45		:05		:25	
:50		:10		:30	
:55		:15		:35	
9:00		:20		:40	
:05		:25		:45	

**CODE:**

**INDIRECT CARE**

- I-1 = Paperwork, meetings, telephone
- I-2 = Other

**DIRECT CARE**

- D-1 = Patient in Class 1 (Self-care)
- D-2 = Patient in Class 2 (Partial-care)
- D-3 = Patient in Class 3 (Total-care)

Figure 29. Time Study Form.

Indirect care activities were recorded as I-1 or I-2.

By adding these two parts together over each shift the total amount of indirect care (I) was determined for each shift.

The breakdown of indirect care into I-1 and I-2 was included although not essential to this study to facilitate determination of time spent on non-productive activities.

The direct care activities were recorded as D-1, D-2, or D-3. The number portion of the code indicates patient category for direct care. This was determined from the "Patient Classification Form" which was posted on the bulletin board daily. Thus, one of the five codes and an associated time, to the nearest five minutes, were recorded for each activity completed. Brief descriptions of the codes are contained on the front of each time sheet with a more detailed check list given on the back. An instruction sheet was also given to each staff member. The format of the "Code Check List" and "Instruction Sheet" is shown in Figure 30.

## CODE CHECK LIST

### INDIRECT CARE - ADMINISTRATIVE DUTIES

I-1:

Clerical  
CSR - Supplies  
Dietary  
Housekeeping  
Lab - Supplies  
Specimens  
Laundry  
Mail  
Medical Records  
Meetings  
Preparing Medications  
Teaching  
Telephoning

I-2:

Coffee  
Meals  
Personal Conversation  
Trips to  
Payroll  
Personnel Office  
Waiting for  
People,  
Supplies  
Washroom

### DIRECT CARE - DIRECT PATIENT CARE

Assisting Doctor  
Bathing Patient  
Escorting Patient  
Giving Treatments

Observing Patient  
Teaching Patient  
Talking to Patient

## INSTRUCTION SHEET

1. Obtain your patient's Class Number from Head Nurse before starting work.
2. Fill in Title, Unit, Date, Shift.
3. Underline time starting work.
4. Determine what Code to use. i.e., what activity you are doing.
5. If Indirect Care, decide I-1 or I-2.
6. If Direct Care, decide D-1, D-2, D-3 where the numbers 1, 2, 3 mean patient's class as obtained from Head Nurse.
7. Record Code in Code Column.
8. Underline the Time (to the nearest 5 minutes) the activity is complete.

Figure 30. Code Check List and Instruction Sheet.

Daily analysis of the time sheets yielded the results shown in Table 2.

Table 2. DAILY ANALYSIS OF TIME SHEETS FOR TWO UNITS.

Nov. 14-21/73		NEUROLOGY UNIT				2-N WARD UNIT			
		I	a <sub>1</sub>	a <sub>2</sub>	a <sub>3</sub>	I	a <sub>1</sub>	a <sub>2</sub>	a <sub>3</sub>
<u>DAY</u>	WED	11.33	0.30	0.79	2.11	14.74	0.72	0.39	2.96
	THUR	19.59	0.24	1.73	0.61	14.33	0.17	0.97	3.13
	FRI	15.17	0.34	1.28	6.42	15.83	0.75	1.47	4.75
	SAT	12.75	0.22	1.26	1.14	7.91	1.00	1.92	1.59
	SUN	10.33	0.28	1.41	1.56	6.25	0.58	1.42	2.19
	MON	20.25	0.91	1.63	1.19	14.00	0.86	1.57	4.33
	TUES	22.59	0.52	1.53	5.50	13.25	0.78	1.82	4.61
	TOTAL HRS.	112.01	2.81	9.63	18.53	86.31	4.86	9.56	23.56
AVERAGE		16	0.40	1.38	2.65	12.33	0.69	1.37	3.37
<u>EVENING</u>	WED	10.50	0.19	0.42	0.61	8.08	1.39	0.06	1.79
	THUR	8.58	0.18	0.56	2.59	6.91	0.33	0.61	3.13
	FRI	10.41	0.33	0.27	0.64	4.50	1.50	1.33	2.84
	SAT	11.08	0.37	0.19	0.44	7.34	0.53	1.75	1.78
	SUN	12.25	0.22	0.31	0.22	6.75	0.57	1.90	1.69
	MON	10.83	0.08	0.58	-	6.17	0.55	1.32	2.11
	TUES	17.33	0.07	0.47	-	5.00	0.42	1.15	2.72
	TOTAL HRS.	80.98	1.44	2.80	4.50	44.75	5.29	8.12	16.06
AVERAGE		11.57	0.21	0.40	0.90	6.39	0.76	1.16	2.29
<u>NIGHT</u>	WED	18.34	0.22	0.49	-	5.66	0.07	0.07	3.33
	THUR	10.33	0.02	0.75	0.58	8.91	0.66	0.47	1.84
	FRI	9.25	0.02	0.92	1.08	11.09	0.19	0.14	5.96
	SAT	7.00	0.02	1.40	0.61	7.66	0.19	0.93	3.42
	SUN	14.17	0.12	1.32	0.81	4.25	0.08	2.75	2.92
	MON	14.34	0.12	1.09	1.14	7.08	0.07	2.73	1.98
	TUES	17.42	0.40	0.45	0.17	-	-	-	-
	TOTAL HRS.	90.85	0.92	6.42	4.39	44.65	1.26	7.09	19.45
AVERAGE		12.98	0.13	0.92	0.73	7.44	0.21	1.18	3.24

Further details on the analysis of the time sheets is included in Appendix F.

The results were averaged for the week to give the following equations:

NEUROLOGY UNIT

DAY  $WLI = 16 + 0.4N_1 + 1.4N_2 + 2.7N_3$

EVENING  $WLI = 11.5 + 0.2N_1 + 0.4N_2 + 0.9N_3$

NIGHT  $WLI = 13 + 0.1N_1 + 0.9N_2 + 0.7N_3$

2-N WARD

DAY  $WLI = 12.5 + 0.7N_1 + 1.4N_2 + 3.4N_3$

EVENING  $WLI = 6.5 + 0.8N_1 + 1.2N_2 + 2.3N_3$

NIGHT  $WLI = 7.5 + 0.2N_1 + 1.2N_2 + 3.2N_3$

The benefits of this kind of time study to the hospital administration are:

1. No specially trained personnel required to conduct study.
2. Can obtain parameters for allocating staff daily.
3. No special tools needed for analysis.
4. Forms are easy to use - designed to fit uniform pocket.
  - hand-size.
  - requires only pen and watch.
  - complete instructions included.
5. Can be used randomly during the year to update parameters.
6. Less costly than conventional methods.



The benefits of the time study to nursing personnel are:

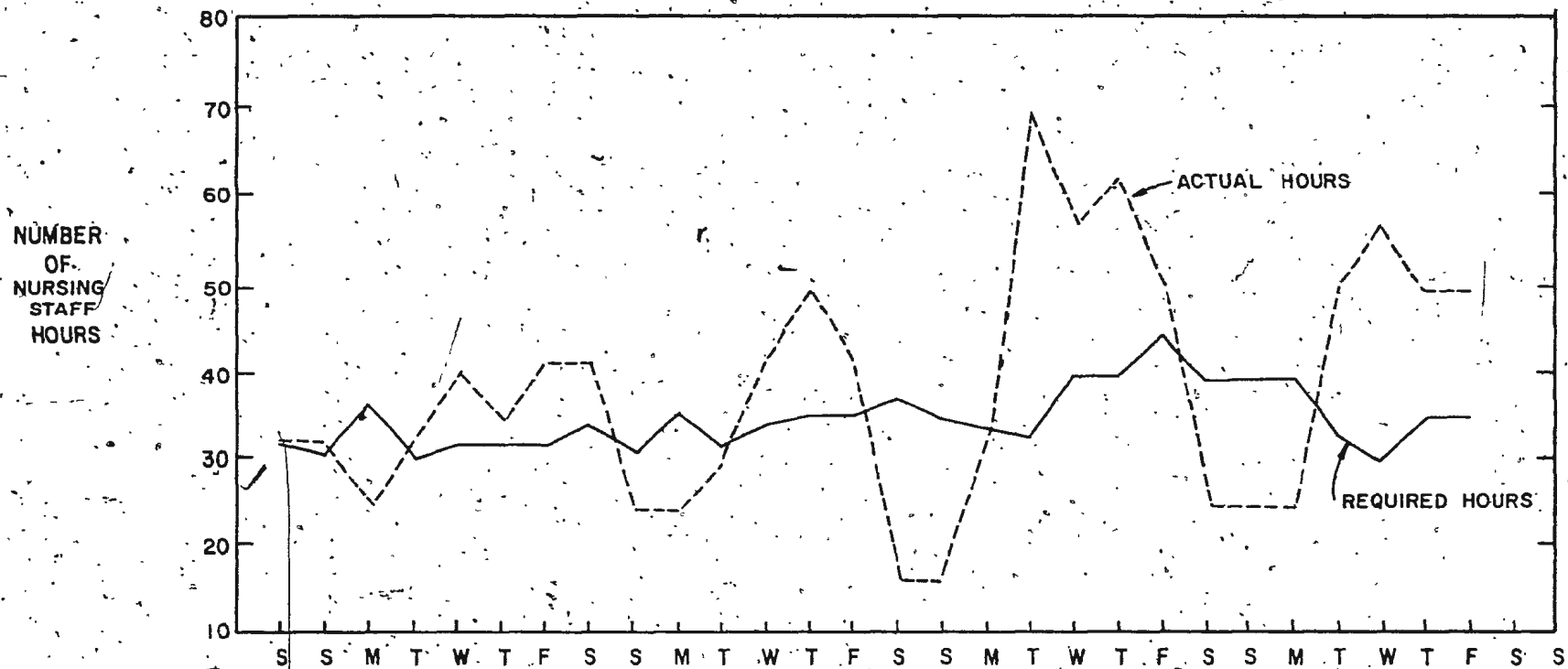
1. Improved work schedules.
2. Parameters are provided to equalize workloads.
3. Job awareness.

#### 4.3.2 Debugging Programs

The three computerized components of the scheduling system were tested and debugged over a three-month period on the Neurology Unit. During this period various improvements and modifications were made to the computer programs. The format of the output reports were evaluated and finalized. Gradual implementation of full cyclic scheduling is nearly accomplished on the unit. However, only partial potential of the system is being realized since present allocation procedures remain unchanged.

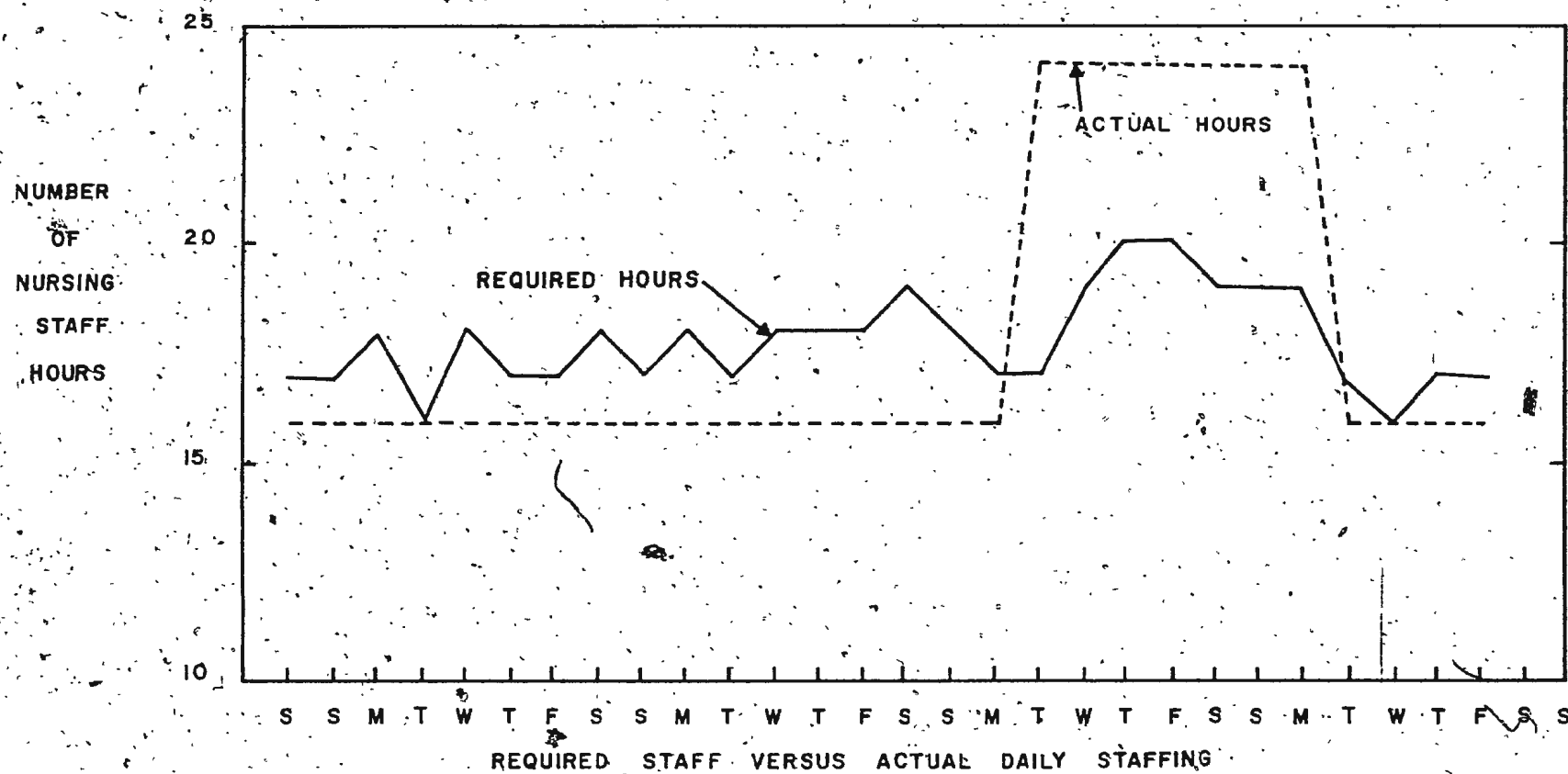
#### 4.3.3 Monitoring of Manpower

Two units were selected for one month and patients classified to obtain a workload index daily. The purpose of monitoring the workload daily was to determine the utilization of present levels of staff. This was also used to estimate the time saving that could be effected by objectively allocating available staff. Graphs of the fluctuations in patient care are shown in Figures 31-36 for both units. The head nurse and team leader are excluded in the actual number of nursing hours



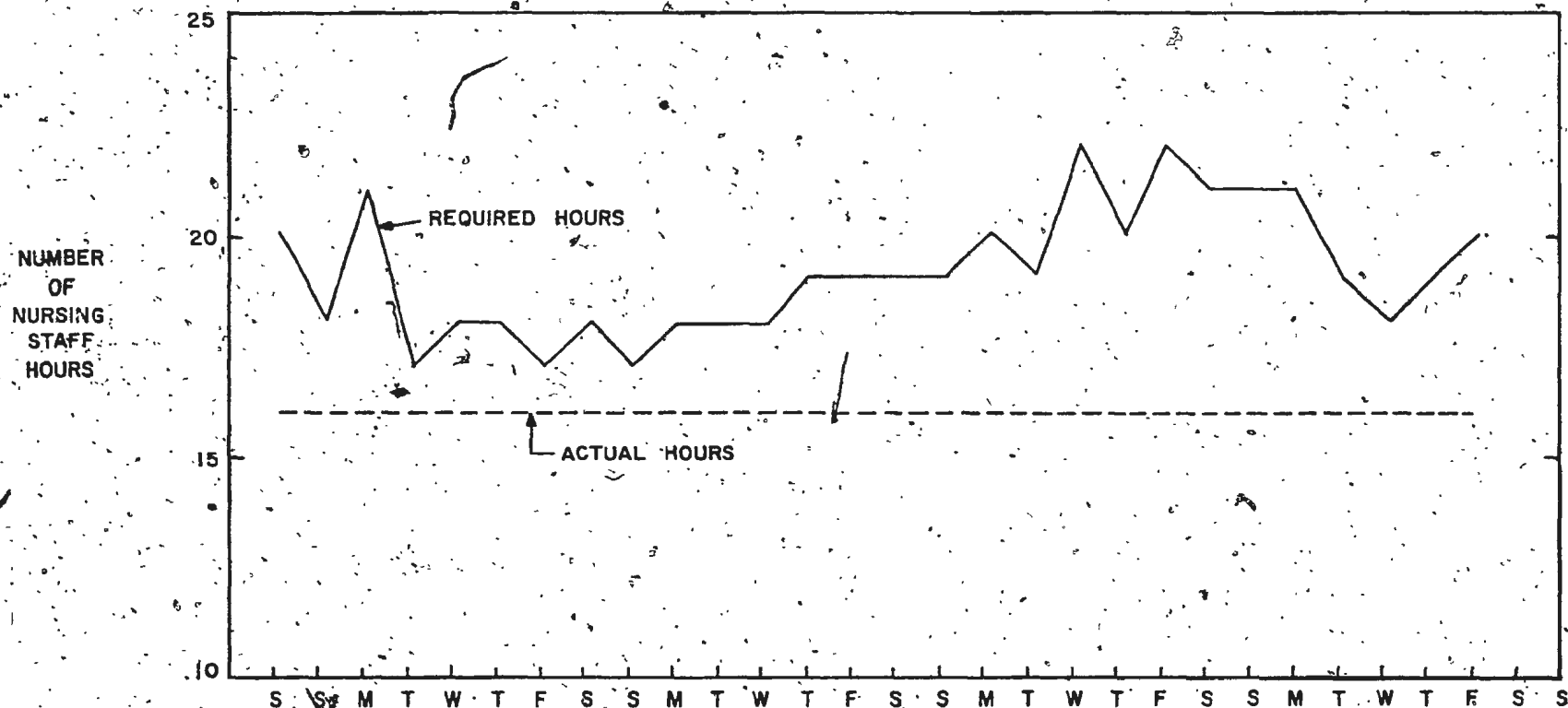
REQUIRED STAFF VERSUS ACTUAL DAILY STAFFING  
(16-BED UNIT, FEB 2 - MAR 1, 1974)

Figure 31. Staffing on Neurology Unit - Day Shift.



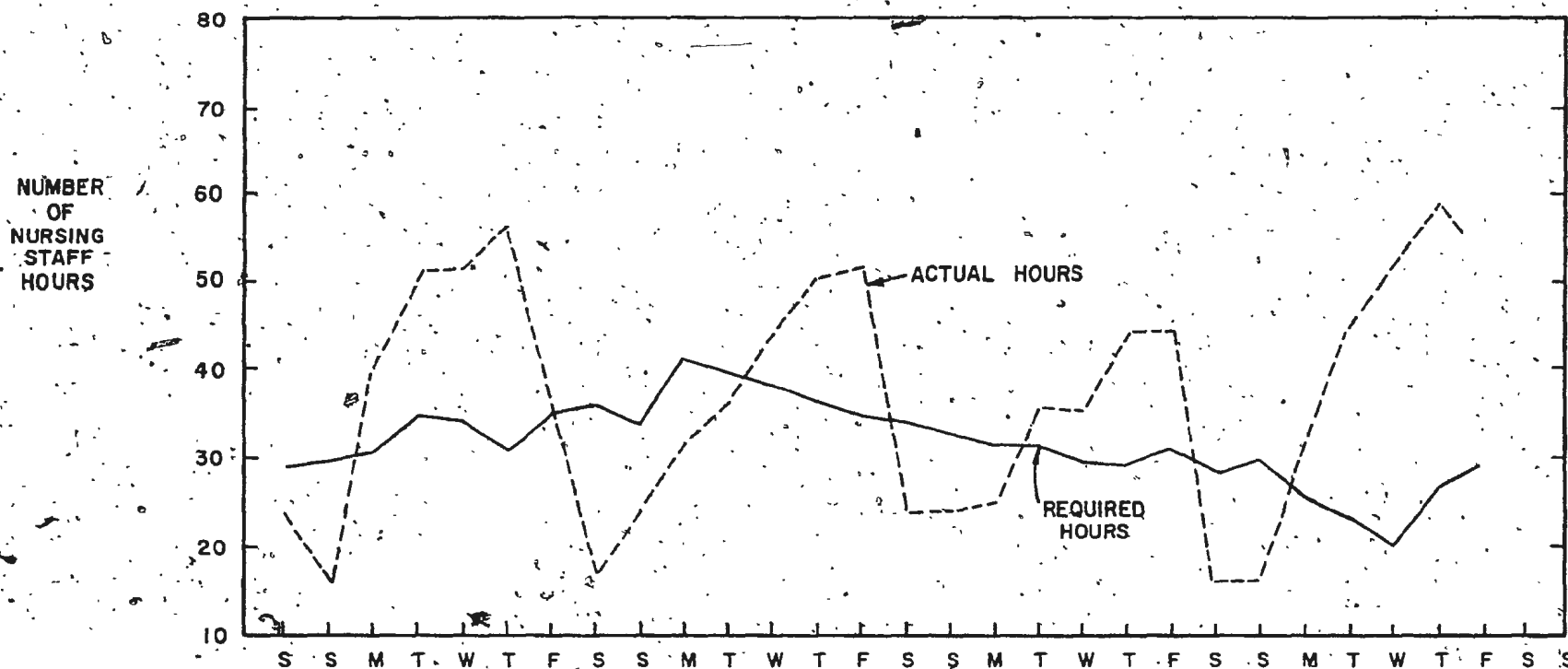
(16-BED UNIT, FEB. 2 - MAR. 1, 1974)

Figure 32. Staffing on Neurology Unit - Evening Shift.



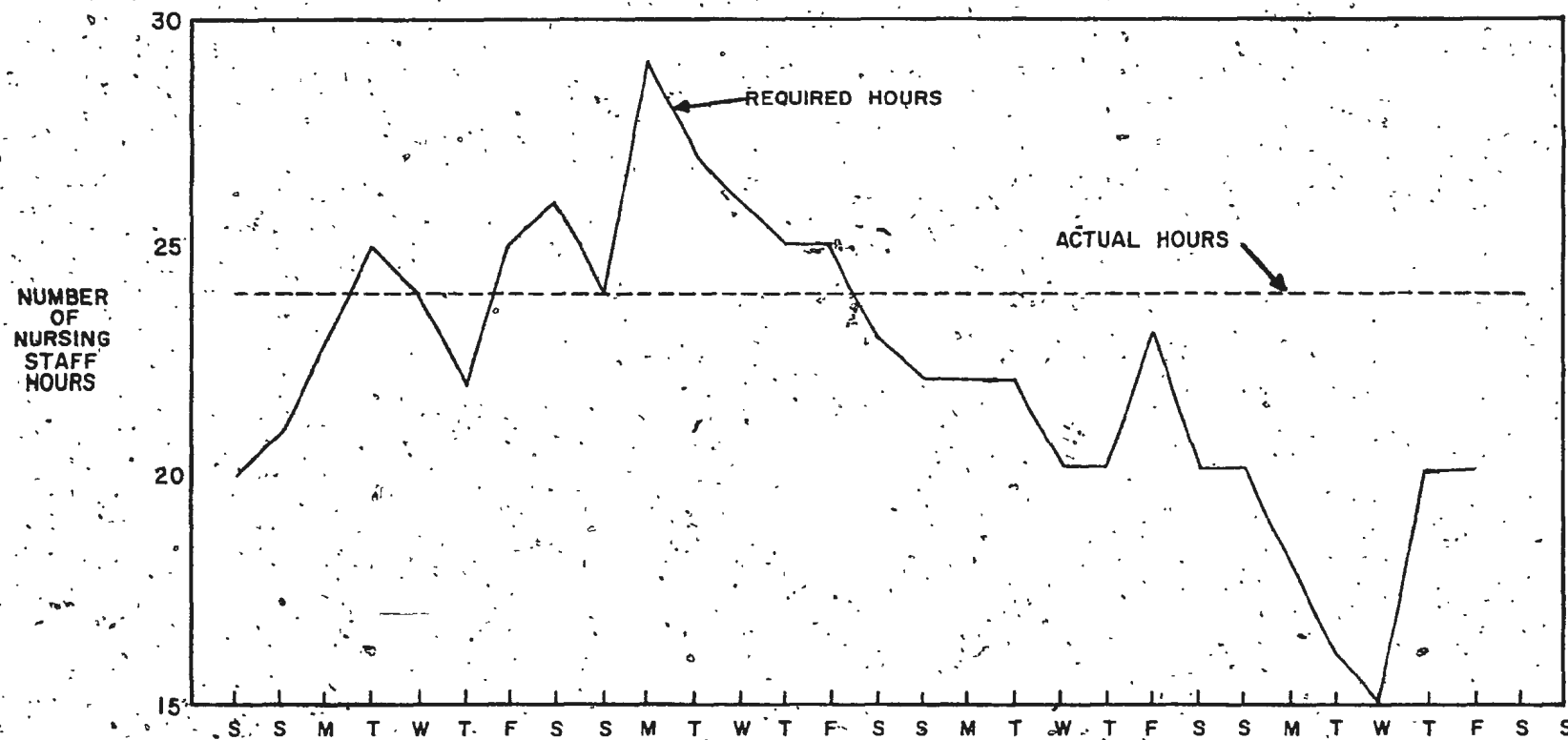
REQUIRED STAFF VERSUS ACTUAL DAILY STAFFING  
(16-BED UNIT, FEB 2-MAR.1, 1974)

Figure 33. Staffing on Neurology Unit - Night Shift.



REQUIRED STAFF VERSUS ACTUAL DAILY STAFFING  
(16-BED UNIT, FEB 2-MAR 1, 1974)

Figure 34. Staffing on 2-N Ward - Day Shift.



REQUIRED STAFF VERSUS ACTUAL DAILY STAFFING  
(16-BED UNIT, FEB-2 - MAR-1, 1974)

Figure 35. Staffing on 2-N Ward - Evening Shift.

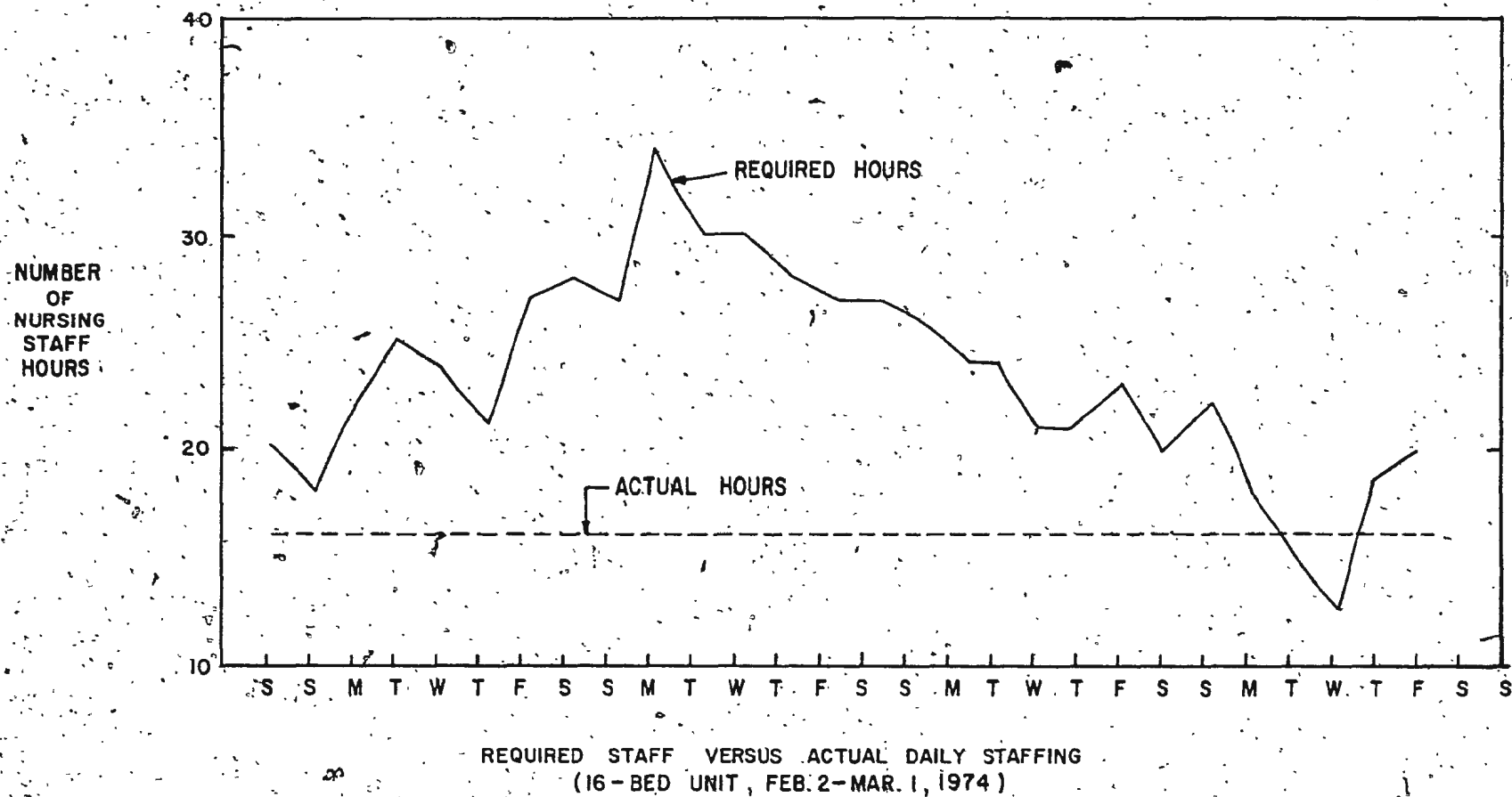


Figure 36. Staffing on 2-N Ward - Night Shift.

provided. Student<sup>9</sup> nurses work only in the day shift and are considered to provide six hours of care per shift worked. Large variations in staffing occur mainly in the day shift. Excess staff indicates low utilization and unwarranted costs. Evidence here points to potential savings in time by better utilization of the available nursing resources.

#### 4.3.4 Estimate of Time Savings

The estimate of time savings from installation of the system is based on savings in head nurses' time and in overtime<sup>10</sup> due to more efficient use of nursing staff. The time savings are summarized as follows:

Estimated saving in overtime per year	= 17,550 Hrs.
Estimated savings in head nurses' time per year	= <u>4,248 Hrs.</u>
Total-Saving	<u>21,798 Hrs.</u>

Details of calculations follow on the next page.

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<sup>9</sup> First year nurses in training.

<sup>10</sup> Difference in actual hours of care provided and that required.



OVERTIME CALCULATION

Average overtime per unit (Figure 31, 34) = 128.5 Hr./4 Wks.

Nurses' contribution<sup>11</sup> = .75 x 128.5 = 96.4 Hr./4 Wks.

Total overtime for 14 units for one year =  $14 \times 96.4 \times \frac{52}{4} = 17,550$  Hr.

HEAD NURSES' CALCULATION

Time spent on scheduling per month [35] = 354 hours

Total of head nurses' time =  $354 \times 12 = 4,248$  Hrs.

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<sup>11</sup> Student nurses are considered to contribute 25% to overtime.

#### 4.3.5 Cost Estimate of Computer Operation

An investigation was conducted to determine the costs of an on-line computer operation of the system. The costs shown in Table 3 are the approximate installation and rental costs of representative computer terminals. Installation costs are fixed with terminal rental rates being charged monthly. The cost of computer processing time is not included in the terminal rental cost. This varies with the usage of the computer by the programs. The yearly cost of time-sharing an IBM 370/155 computer using an IBM 2741 terminal is estimated to be \$23,460 with initial installation cost of approximately \$100. Further details of the estimate are given below:

Estimated computer processing costs	= \$1000/Mo.
Estimated rental cost of IBM 2741 terminal	= 120/Mo.
Estimated salary cost of computer operator	= <u>835/Mo.</u>
Total monthly cost	= \$1955
Annual cost = 1955 x 12	= <u>\$23,460</u>

Table 3. Economics of Selected Computer Hardware.

Representative	Equipment	Installation	Total Installation	Rental per Mo.	Total Rental/Mo.
1. Nfld. Tel.	Vucom I Display	\$25	\$75	\$70	\$200
	Impact Printer	50		130	
2. Nfld. Tel.	Vucom I Display	25	\$50	70	165
	Non-Impact Printer	25		95	
3. Nfld. Tel.	Datacom 300	50	50	130-250	130-250
4. Nfld. Tel.	TWX	30	30	40-135	40-135
5. Nfld. Tel.	Comterm 2060	500	500	2,500	2,500
6. NLCS	IBM 2741	100	100	120	120
7. NLCS	TTY-35 "PSA"	30	30	90	90
8. NLCS	Comterm 2100	500	500	2,800	2,800
9. NLCS	TWX/33	20	20	150	150
10. NLCS	IBM 3275	230	230	250	250
11. NCR	NCR 399	300	300	550	550
12. CPCN	Telex 33	25	25	50 +.10/Min	50 +.10/Min

Where Nfld. Tel. = Newfoundland Telephone Company  
 NLCS = Newfoundland and Labrador Computer Services  
 NCR = National Cash Register  
 CPCN = Canadian Pacific/Canadian National  
 IBM = International Business Machines Corporation

## 5. CONCLUSION

This report has described a nurse scheduling system which solves present scheduling problems and meets stated objectives.

The system is in the process of being implemented on one unit at the General Hospital. An optimal use of available personnel is achieved using cyclical scheduling and an allocation method. The four components of the system combine to yield a total scheduling package. Automation of part of the system helps the user form optimal schedules within given constraints.

### 5.1 BENEFITS

Cyclical scheduling produces work schedules that are recurrent. The schedules are fair to staff members with shifts being distributed equally. Nursing personnel know their schedules in advance and can plan recreational activities accordingly. This results in less requests for days off. Centralization of scheduling eliminates the time spent by the head nurse on scheduling and also the potential charges of favouritism on the part of the head nurse. The new system uses float, permanent and part-time staff to augment the regular staff work schedules.

The workload and allocation component of the system provides an objective method to adjust staff to meet patient needs. The new time study method allows quick determination of parameters for workload prediction. Overstaffing is avoided and a uniform

level of care maintained. A measure of staff utilization is introduced so that a lower overall level of staff can be maintained within the hospital.

Automation of the three scheduling components introduces speed and flexibility into the system. More combinations of schedules can be tried until an optimal result is attained. Continuous updating of unit schedules is permitted so that nursing resources are monitored daily. Manpower availability can be forecasted so that seasonal fluctuations are foreseen and recruitment started early enough to absorb shortages.

The nurse scheduling system is general enough so that any hospital may use it. Each component of the system is independent of the other so that it can be selected and used to fulfill a specific need. Implementation of the system is enhanced because all components are user-oriented. Thus, the system may be used by any hospital interested in establishing a method to effectively schedule and control nursing resources.

## 5.2 FUTURE WORK

Future work on the system could include automating the workload and allocation component. More management reports on nursing performance, cost indicators and quality of care are also needed. The nursing performance reports could include indicators of utilization, overtime, turnover, absenteeism and job satisfaction. Reports on costs could include cost/patient day, salary costs, overtime costs and manpower cost/day. Reports on the quality of care could include indicators which make both the administration and the employees more aware of the factors that ensure high quality of care.

## 5.3 RECOMMENDATIONS

As a result of this study it is recommended that:

1. Nurse scheduling be centralized.
2. The cyclical scheduling method be used to schedule nursing personnel.
3. Flexibility be developed in the work schedule by using float, part-time and permanent shift staff.
4. An objective method be used to allocate nursing staff daily.

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APPENDIX A

1. Work Pattern Selector Program-Named "Nurse 1".
2. Work Schedule Assembler Program-Named "Nurse 2".
3. Work Schedule Projector Program-Named "Nurse 3".

"NURSE 1" PROGRAM

-----WORK PATTERN SELECTOR-----

-----PARTIAL LIST PROGRAM VARIABLES-----

ARRAY(49)	OUTPUT ARRAY OF PATTERNS
ANS	INDICATOR FOR ANOTHER RUN
D(3)	COVERAGE REQ'D ON DAY SHIFT
DAYS(7)	DAYS OF WEEK
D1(3)	COVERAGE ON DAY SHIFT
D2(3)	COVERAGE ON EVENING SHIFT
D3(3)	COVERAGE ON NIGHT SHIFT
E(3)	COVERAGE ON EVENING SHIFT
INF	INDICATOR FOR INFORMATION
N(3)	COVERAGE REQ'D ON NIGHT SHIFT
P(3)	STAFF NEEDED FOR COVERAGE
PER(3)	RN'S, NI'S, NA'S AVAILABLE
REDUCE	WEEKEND INDICATOR
S(3)	TOTAL EACH CATEGORY-WEEKDAY
SS(3)	TOTAL ON EACH SHIFT-WEEKDAY
S1(3)	TOTAL EACH CATEGORY-WEEKDAY
S2(3)	TOTAL EACH CATEGORY-WEEKEND
SS1(3)	TOTAL SHIFTS - WEEDAYS
SS2(3)	TOTAL SHIFTS - WEEKENDS
TYPE(7,7)	SEVEN BASIC WEEK TYPES
WEEK(49)	WEEK HEADING
W3(2,10)	3 WEEK PATTERNS
W4(3,11)	4 WEEK PATTERNS
W5(7,12)	5 WEEK PATTERNS
W6(5,13)	6 WEEK PATTERNS
W7(1,14)	7 WEEK PATTERNS

-----IMPLICIT INTEGER(A-Z)-----

```

LOGICAL*1 WEEK(49), DAYS(7), ARRAY(49), TYPE(7,7)
COMMON/HOLD/DAYS, TYPE
DIMENSION W3(2,10), W4(3,11), W5(7,12), W6(5,13), W7(1,14), W51(
42), -
W52(42), W61(32), W62(33), N(3), E(3), D(3), NUM(5), P(3), S(3)
DIMENSION SS(3), S1(3), S2(3), SS1(3), SS2(3), D1(3), D2(3), D3(3),
PER(3)
DATA W3/2,3,5,5,0,0,2,2,2,2,2,3,2,2,3,2,2,2,2,2/
DATA W4/1,2,2,3,3,4,5,5,5,0,0,0,3,3,3,2,3,3,3,3,3,3,2,3,3,3,
3,3,3,3, -
2,3,3,3/
DATA W51/1,1,1,1,2,2,2,2,2,3,3,3,3,4,3,4,4,5,4,5,5,5,5,5,6,
5,6,6,0, -
0,0,0,0,0,0,4,4,4,3,4,3,3/
DATA W52/3,3,3,3,4,4,4,3,3,4,4,4,4,4,3,4,4,4,3,3,4,4,4,3,4,
3,4,4,4, -
3,3,4,3,4,3,4,4,4,3,4,3,3/
DATA W61/1,1,1,1,2,2,2,2,3,3,3,3,4,4,4,4,5,5,5,5,5,6,6,6,6,
0,0,0,0, -
0,5,4/
DATA W62/4,4,4,4,4,4,4,5,4,4,4,5,5,4,4,5,5,4,4,5,5,4,4,4,5,4

```

```

,4,4,5,4,4,4,4/
DATA W7,S,NUM,SEX,SS1,SS2,YES/1,2,3,4,5,6,0,5,5,5,5,5,5,3
*0,7,6,5,4,3,7*0,'YES'/
EQUIVALENCE (W51(1),W5(1)),(W52(1),W5(43)),(W61(1),W6(1))
EQUIVALENCE (W62(1),W6(33))
EQUIVALENCE (PER(1),RN),(PER(2),NI),(PER(3),NA)
PRINT 5
5 FORMAT(/9X,46(' ')/9X,'*',44X,'*'/9X,'*',44X,'*'/9X,'*',
12X,-
'THE GENERAL HOSPITAL',12X,'*'/9X,'*',44X,'*'/9X,'*',4X,-
'WELCOME TO THE WORK PATTERN SELECTOR',4X,'*'/9X,'*',44X,'
*'/-
9X,'*',44X,'*'/9X,46(' ')// )
PRINT 7
7 FORMAT(/1X,'DO YOU WANT INFORMATION ON HOW TO USE THE PR
OGRAM?'-
//1X,'ANSWER YES OR NO ENCLOSED IN SINGLE QUOTES. '//
READ *,INF
IF (INF.NE.YES) GO TO 12
PRINT 10
10 FORMAT(/70(' ')//1X,'INFORMATION'/1X,11(' ')//1X,'PURPO
SE -'-
/9X,'TO SELECT WORK PATTERNS FOR (3) CATEGORIES OF -
STAFF.'/9X,'(EQ. RN'S,NI'S,NA'S) '-
//1X,'INPUT -'//7X,'THE BASIC INPUT IS THE COVERAGE REQUIRED
-
ON EACH SHIFT'/7X,'FOR EACH CATEGORY OF STAFF.'/7X,'WEEKEN
D COVERAGE-
IS ALSO CONSIDERED.'/1X,'OPERATION -'//11X,'THE PROGRAM SE
LECTS-
PATTERNS WHICH GIVE THE MOST EVEN'/11X,'COVERAGE.'/11X,'QU
ESTIONS -
ARE ASKED BY THE COMPUTER AND THE PATTERNS'/11X,'ARE SELECTE
D BASED-
ON THE ANSWERS GIVEN.'/1X,'ASSUMPTIONS -'//13X,'EACH PERSO
N -
WORKS 5 SHIFTS/WEEK.'/13X,'MAXIMUM 7 DAY WORK STRETCH(4,5,6
,7 WEEK PATTERNS),8 FOR 3 WK'-
//13X,'EVERY PERIOD OFF SHALL BE AT LEAST 2 DAYS DURATION.'
-
//1X,'DETAILS -'//9X,'ANSWER YES OR NO IN SINGLE QUOTES UNLE
SS -
SPECIFIED OTHERWISE.'/9X,'PATTERNS ARE LISTED WHERE:'//9X,
'BLANK - WORKDAY'/9X,'O - DAY OFF'/1X,'LIMITS -'//8X,-
'MAXIMUM NUMBER OF EACH CATEGORY WE CAN SCHEDULE AT A TIME =
7'//
70(' ')// )
GO TO 12
14 PRINT 13
13 FORMAT(/1X,'OKAY THEN,LET'S LOOK AT THE WEEKEND COVERAG
E.'//)
SEX=1
12 PRINT 15

```

```

"-----DAY SHIFT
15 FORMAT(/IX,35('--'))/IX,'FIRST,LET''S CONSIDER THE DAY SHIF
T.'/IX,35('--'))/
PRINT 20
20 FORMAT(IX,'HOW MANY R.N.''S ARE NEEDED ON DAY SHIFT?'/)
READ *,D(1)
PRINT 30
30 FORMAT(/IX,'HOW MANY N.I.''S ARE NEEDED ON DAY SHIFT?'/)
READ *,D(2)
PRINT 40
40 FORMAT(/IX,'HOW MANY N.A.''S ARE NEEDED ON DAY SHIFT?'/)
READ *,D(3)
"-----EVENING SHIFT
PRINT 45
45 FORMAT(/IX,36('--'))/IX,'NOW,LET''S CONSIDER THE EVENING S
HIFT.'/IX,36('--'))/
PRINT 50
50 FORMAT(IX,'HOW MANY R.N.''S ARE NEEDED ON EVENING SHIFT?'
/)
READ *,E(1)
PRINT 60
60 FORMAT(/IX,'HOW MANY N.I.''S ARE NEEDED ON EVENING SHIFT
?'/)
READ *,E(2)
PRINT 70
70 FORMAT(/IX,'HOW MANY N.A.''S ARE NEEDED ON EVENING SHIFT
?'/)
READ *,E(3)
"-----NIGHT SHIFT
PRINT 74
74 FORMAT(/IX,35('--'))/IX,'NOW,LET''S CONSIDER THE NIGHT SH
IFT.'/-
IX,35('--'))/
PRINT 80
80 FORMAT(IX,'HOW MANY R.N.''S ARE NEEDED ON NIGHT SHIFT?'/
)
READ *,N(1)
PRINT 90
90 FORMAT(/IX,'HOW MANY N.I.''S ARE NEEDED ON NIGHT SHIFT?'/
)
READ *,N(2)
PRINT 100
100 FORMAT(/IX,'HOW MANY N.A.''S ARE NEEDED ON NIGHT SHIFT?'
/)
READ *,N(3)
IF(SEX.EQ.1) GO TO 123
PRINT 101
101 FORMAT(/IX,'HOW MANY R.N.''S ,N.I.''S ,N.A.''S DO YOU H
AVE AVAILABLE FOR THE UNIT,'//IX,'EXCLUDING THE HEAD NURSE A
ND TEAM LEADER?'/IX,'TYPICAL ANSWER MAY BE 5,4,4'/)
READ *,PER
"-----WEEKEND POLICY
121 FORMAT(/IX,'DO YOU REDUCE STAFF ON WEEKENDS?'/)
PRINT 121

```

```

READ *, REDUCE
"-----STORING INPUT FROM WEEKDAY COVERAGE
DO 122 I=1,3
S1(I)=D(I)+E(I)+N(I)
SS(I)=S1(I)*5
SS1(I)=D(I)+SS1(I)
SS1(2)=E(I)+SS1(2)
SS1(3)=N(I)+SS1(3)
D1(I)=D(I)
D2(I)=E(I)
122 D3(I)=N(I)
IF(REDUCE.EQ.YES) GO TO 14
GO TO 151
"-----FINDING THE COVERAGE ON A WEEKEND
123 DO 124 I=1,3
S2(I)=D(I)+E(I)+N(I)
SS(I)=S2(I)*2+SS(I)
SS2(I)=D(I)+SS2(I)
SS2(2)=E(I)+SS2(2)
124 SS2(3)=N(I)+SS2(3)
"-----NUMBER OF PERSONNEL NEEDED CONSIDERING WEEKEND REDUCTI
ON
DO 125 I=1,3
REM=MOD(SS(I),5)
P(I)=SS(I)/5
IF(REM.GE.3) P(I)=P(I)+1
125 CONTINUE
"-----PRINTING SUMMARY OF COVERAGE-WEEKDAYS-WEEKENDS
PRINT 126
126 FORMAT(/70(' ')/19X,'SUMMARY OF COVERAGE REQUIRED'/19X
,28(' ')/13X,'WEEKDAYS',24X,'WEEKENDS')
PRINT 127
127 FORMAT(13X,8(' ')/24X,8(' ')/8X,'RN',3X,'NI',3X,'NA',3X
,'TOTAL',10X,'RN',3X,'NI',3X,'NA',3X,'TOTAL'//)
PRINT 128,D1,SS1(1),D,SS2(1),D2,SS1(2),E,SS2(2)
128 FORMAT(5X,'D',2X,12,3(3X,12),10X,'D',2X,12,3(3X,12)//5X,
'E',2X,12,3(3X,12),10X,'E',2X,12,3(3X,12))
PRINT 129,D3,SS1(3),N,SS2(3),S1,S2
129 FORMAT(/5X,'N',2X,12,3(3X,12),10X,'N',2X,12,3(3X,12)//1X
,'TOTAL',2X,12,2(3X,12),11X,'TOTAL',2X,12,2(3X,12)//)
GO TO 131
"-----FINDING THE COVERAGE WITH NO WEEKEND REDUCTION OF STAF
F
151 S(1)=D(1)+E(1)+N(1)
S(2)=D(2)+E(2)+N(2)
S(3)=D(3)+E(3)+N(3)
SS(1)=D(1)+D(2)+D(3)
SS(2)=E(1)+E(2)+E(3)
SS(3)=N(1)+N(2)+N(3)
"-----NUMBER OF PERSONNEL NEEDED WITH NO WEEKEND REDUCTION
DO 15 I=1,3
SSS=S(I)*7
REM=MOD(SSS,5)
P(I)=SSS/5

```



```

IF(REM.GE.3) P(1)=P(1)+1
115 CONTINUE
"-----PRINTING COVERAGE WITH NO REDUCTION
PRINT 116
116 FORMAT(//70('*')//20X,'SUMMARY OF COVERAGE REQUIRED'/20
X,28('-')//)
PRINT 118,D,SS(1),E,SS(2),N,SS(3),S
118 FORMAT(28X,'RN',3X,'NI',3X,'NA',2X,'TOTAL'//25X,'D',2X,
12,-
3(3X,12)//25X,'E',2X,12,3(3X,12)//25X,'N',2X,12,3(3X,12)//21
X,'TOTAL',-
2X,12,2(3X,12)//)
"-----PRINTING STAFF REQUIRED TO GIVE COVERAGE
131 PRINT 119
119 FORMAT(20X,'NUMBER OF PERSONNEL'/20X,19('-')//9X,'NEEDED
',15X,'AVAILABLE',7X,'SELECTED'//)
PRINT 153,P(1),PER(1),PER(1),P(2),PER(2),PER(2),P(3),PER(3),
PER(3)
153 FORMAT(1X,'RN',8X,12,20X,12,13X,12//1X,'NI',8X,12,20X,12
,13X,12//1X,'NA',8X,12,20X,12,13X,12//70('*')/1X,'*',67X,'*'
/1X,'*',67X,'*')
"-----FIRST WE SCHEDULE THE R.N.'S
PRINT 132
132 FORMAT(1X,'*',18X,'LIST OF PATTERNS SELECTED',24X,'*'/1X
,'*',67X,'*'/1X,'*',67X,'*'/70('*')//)
IF(PER(1).LE.7) GO TO 133
IND=1
CALL PRINT(&180)
133 IND=1
PRINT 134
134 FORMAT(//20X,'LIST OF PATTERNS FOR R.N.'*S'/20X,27('='
)//)
GO TO(120,120,130,140,150,160,170),RN
112 IF(PER(2).LE.7) GO TO 13 5
CALL PRINT(&180)
135 PRINT 136
136 FORMAT(//20X,'LIST OF PATTERNS FOR N.I.'*S'/20X,27('='
)//)
GO TO(120,120,130,140,150,160,170),NI
114 IF(PER(3).LE.7) GO TO 137
CALL PRINT(&190)
137 PRINT 138
138 FORMAT(//20X,'LIST OF PATTERNS FOR N.A.'*S'/20X,27('='
)//)
GO TO(120,120,130,140,150,160,170),NA
120 PRINT 154
154 FORMAT(//1X,'THIS SCHEDULING PACKAGE IS DESIGNED TO SCHE
DULE 3 TO 7 PERSONNEL AT A TIME.'//)
GO TO 190
"-----3-WEEK COMBINATION
130 CALL PAT(ARRAY,W3,WEEK,2,3,10)
GO TO 180
"-----4-WEEK COMBINATION
140 CALL PAT(ARRAY,W4,WEEK,3,4,11)

```

```

GO TO 180
"-----5-WEEK COMBINATION
150 CALL PAT(ARRAY,W5,WEEK,7,5,12)
GO TO 180
"-----6-WEEK COMBINATION
160 CALL PAT(ARRAY,W6,WEEK,5,6,13)
GO TO 180
"-----7-WEEK COMBINATION
170 CALL PAT(ARRAY,W7,WEEK,1,7,14)
180 IND=IND+1
GO TO (112,112,114),IND
190 CONTINUE
PRINT 194
194 FORMAT(//IX,'GOOD-BYE,SEE YOU NEXT TIME.'//)
END
SUBROUTINE PAT(A,IWK,IWEEK,L,M,MM)
IMPLICIT INTEGER(A-Z)
LOGICAL*1 DD(7),IWEEK(49),A(49),IYPE(7,7)
COMMON /HOLD/DD,IYPE
DIMENSION IWK(L,MM)
JJ=1
DO 5 K=1,M
DO 5 J=1,7
IWEEK(JJ)=DD(J)
5 JJ=JJ+1
JJ=JJ-1
PRINT 10,(IWEEK(J),J=1,JJ)
10 FORMAT(IX,'PATTERN NO.',IX,7(7A1,IX))
DO 30 I=1,L
KK=1
DO 20 J=1,M
DO 20 K=1,7
LIM=IWK(I,J)+1
A(KK)=IYPE(LIM,K)
20 KK=KK+1
30 PRINT 40,1,(A(11),11=1,JJ)
40 FORMAT(6X,12,5X,7(7A1,IX))
PRINT 50
50 FORMAT(//15X,'DAILY COVERAGE FOR EACH PATTERN ABOVE'//15X,
37('-'//))
PRINT 60
60 FORMAT(18X,'PATTERN NO.',5X,12,M T W T F S S'//)
MMM=M+1
DO 70 I=1,L
70 PRINT 80,1,(IWK(I,K),K=MMM,MM)
80 FORMAT(23X,12,9X,7I2)
PRINT 90
90 FORMAT(//70(' '))
RETURN
END
SUBROUTINE PRINT(*)
PRINT 10
10 FORMAT(//IX,'IT IS IMPOSSIBLE TO SELECT A PATTERN,SINCE TH
E NUMBER OF STAFF REQUIRED IS GREATER THAN SEVEN.'//)

```

```
RETURN 1
END
BLOCK DATA
LOGICAL*1 DAYS(7),TYPE(7,7)
COMMON/HOLD/DAYS,TYPE
DATA DAYS/'M','T','W','T','F','S','S'/
DATA TYPE/'0',5*' ',3*'0',6*' ',2*'0',6*' ',2*'0',6*' ',2*'
0',-
6*' ',2*'0',6*' ',2*'0'/
END
```

"NURSE 2" PROGRAM

-----WORK SCHEDULE ASSEMBLER-----  
 " PARTIAL LIST PROGRAM VARIABLES  
 "-----

"--	ARRAY(7,49,3)	EXPANDED PATTERNS
"--	A(7,49,3)	EXPANDED PATTERNS
"--	AA(7,49,3)	EXPANDED PATTERNS
"--	AI(7,49,3)	EXPANDED PATTERNS
"--	ANS	INDICATOR
"--	ANSS	INDICATOR
"--	CR(3,49)	ARRAY OF COVERAGE
"--	C(3,49)	ARRAY OF COVERAGE
"--	CC(3,49)	ARRAY OF COVERAGE
"--	CS(3,49)	ARRAY OF COVERAGE
"--	CT(3,49)	ARRAY OF COVERAGE
"--	CRT(3,49,4)	TOTAL COVERAGE
"--	CAT(3)	PATTERN LENGTH
"--	DAYS(7)	DAYS OF WEEK
"--	INF	INDICATOR
"--	IND	INDICATOR
"--	INDIC	INDICATOR
"--	KIND(3)	NAME OF WORK CATEGORY
"--	LEN	LENGTH OF WORK PATTERN
"--	LL	LENGTH OF WORK PATTERN
"--	NUMB(3)	NUMBER PERMANENT STAFF
"--	OH	LETTER X
"--	PAT(7,7,3)	WORK PATTERNS FOR STAFF
"--	P(7,7,3)	WORK PATTERNS FOR STAFF
"--	PS(7,49,3)	PERMANENT STAFF PATTERNS
"--	PPP(7,49,3)	PERMANENT STAFF PATTERNS
"--	PERM	INDICATOR
"--	PARM	INDICATOR
"--	REV(7)	ARRAY FOR REVISIONS
"--	REVISE	REVISION NUMBER
"--	ROT(3)	ARRAY OF SHIFT TYPES
"--	RUN	RUN NUMBER
"--	SAT	INDICATOR
"--	S(1,7)	WORKING ARRAY
"--	STR(14)	MIN AND MAX ARRAY
"--	TYPE(3)	NAME OF WORK CATEGORY
"--	T(7,49,3)	PERMANENT
"--	WEEK(49)	WEEK HEADING
"--	WKNO	WEEK NUMBER
"--	WK(49)	WEEK HEADING
"--	W(49)	WEEK HEADING

-----  
 IMPLICIT INTEGER (A-Z)  
 DIMENSION PAT(7,7,3),DAYS(7),WEEK(49),ARRAY(7,49,3),REV(7),P  
 S(7,49,3),ROT(3),CR(3,49),CRT(3,49,4),CS(3,49),CAT(3),KIND(3  
 )  
 DATA OH,ROT,DAYS,BLA,CRT,CAT,YES,IND,INDIC,RUN/'X','D','E',  
 N,'M','T','W','T','F','S','S',',588\*0,3\*0,'YES',3\*0/  
 PRINT 10  
 10 FORMAT(/9X,46(' ')/9X,'\*',44X,'\*/9X,'\*',44X,'\*/9X,'\*'

12X, 'THE GENERAL HOSPITAL', 2X, '\*' / 9X, '\*', 44X, '\*' / 9X, '\*', 1X,

WELCOME TO THE WORK SCHEDULE ASSEMBLER', '\*' / 9X, '\*', -  
44X, '\*' / 9X, '\*', 44X, '\*' / 9X, 46(''') / )

PRINT 5

5 FORMAT(//1X, 'DO YOU WANT INFORMATION ON HOW TO USE THE PR  
OGRAM?' //1X, 'ANSWER YES OR NO ENCLOSED IN SINGLE QUOTES.' / )

READ \*, INF

IF(INF.NE.YES) GO TO 15

PRINT 6

6 FORMAT(//70(''') //1X, 'INFORMATION' / 1X, 11(''') //1X, 'PURPOS  
E - '

//9X, 'TO WORK OUT DAILY SCHEDULES FOR (3) CATEGORIES OF STAF  
F.' / 9X, -

'(EG. RN''S, NI''S, NA''S)' //1X, 'INPUT - '

PRINT 7

7 FORMAT(7X, 'THE BASIC INPUT IS A PATTERN (SHOWING DAYS OF  
F AND SHIFTS)' / 7X, -

WHICH MAY BE SELECTED USING "NURSEI" PROGRAM OR WORKED OUT' /  
7X, 'INDEPENDENTLY .')

PRINT 8

8 FORMAT(//1X, 'OPERATION -' //11X, 'THE PROGRAM SCHEDULES ST  
AFF IN A CYCLIC -

MANNER AND REPORTS' / 11X, 'ON EACH SCHEDULE PRODUCED.' //11X, 'T  
HE OPERATOR-

ANSWERS A SERIES OF QUESTIONS THAT THE COMPUTER' / 11X, 'ASKS  
AND CHANGES -

EACH SCHEDULE UNTIL A SATISFACTORY SHIFT' / 11X, 'COVERAGE, AND  
PERSONNEL MIX IS OBTAINED.')

PRINT 9

9 FORMAT(//1X, 'DETAILS -' //9X, 'ANSWER YES OR NO, IN SINGLE Q  
UOTES -

UNLESS SPECIFIED OTHERWISE.' T:-

//9X, 'THE PATTERN IS ENTERED SHOWING DAYS OFF, -

AND SHIFTS WHERE:' //9X, 'X - DAY OFF', T35, 'R - REQUESTED DAY  
OFF' / 9X, 'D - DAY SHIFT', T35, 'S - SICK LEAVE' / 9X, 'E - EVENING

SHIFT', T35, 'O - DAY OWED' -

/ 9X, 'N - NIGHT SHIFT', T35, 'T - NURSING DISTRICT' / 9X, 'A - ANN  
UAL -

LEAVE', T35, 'C - CLASS DAY' //9X, 'PATTERN LENGTH IS IN WEEKS.' /  
9X, -

'TYPING CODE FOR PATTERNS:-' //9X, '0 - DAY OFF', T35, '5 - REQU  
ESTED -

DAY OFF' / 9X, '1 - DAY SHIFT', T35, '6 - SICK LEAVE' / 9X, '2 - EVE  
NING -

SHIFT', T35, '7 - DAY OWED' / 9X, '3 - NIGHT SHIFT', T35, '8 - NURS  
ING -

DISTRICT' / 9X, '4 - ANNUAL LEAVE', T35, '9 - CLASS DAY' //9X, 'NOT  
E: CODES 0 - 3 USED IN THIS PROGRAM.' //1X, 'LIMITS -

-' //9X, -

'MAXIMUM PATTERN LENGTH = 7 WEEKS' //9X, 'MAXIMUM NUMBER OF

PERSONS IN EACH CATEGORY = 7' //70(''') / )

```

15 PRINT 12
12 FORMAT(/IX, 'STAFF CATEGORY?')
IND=IND+1
READ *, KIND(IND)
PRINT 20
20 FORMAT(/IX, 'PATTERN LENGTH?')
  READ *, LEN
  CAT(IND)=LEN
  LL=LEN*7
  PRINT 30
30 FORMAT(/IX, 'PATTERN?')
READ *, ((PAT(I,J,IND), J=1,7), I=1,LEN)
DO 21 I=1,LEN
DO 21 J=1,7
  IF(PAT(I,J,IND).EQ.0) PAT(I,J,IND)=OH
  IF(PAT(I,J,IND).EQ.1) PAT(I,J,IND)=ROT(1)
  IF(PAT(I,J,IND).EQ.2) PAT(I,J,IND)=ROT(2)
  IF(PAT(I,J,IND).EQ.3) PAT(I,J,IND)=ROT(3)
21 CONTINUE
JJ=1
DO 25 I=1,LL
DO 25 J=1,7
  WEEK(JJ)=DAYS(J)
25 JJ=JJ+1
"-----PRINTING INPUT
PRINT 65, LEN, KIND(IND)
65 FORMAT(/IX, 'PATTERN CHOSEN FOR ', I1, IX, A4/IX, 25(' ')/)
  PRINT 84, (WEEK(J), J=1,LL)
PRINT 84, ((PAT(I,J,IND), J=1,7), I=1,LEN)
84 FORMAT(7(IX, 7A1))
85 FORMAT(IX, 'EMPLOYEE', 7(IX, 7A1))
"-----EXPANDING PATTERN
PRINT 78, LEN, KIND(IND)
78 FORMAT(/9X, 'SHIFT SCHEDULE FOR ', I1, IX, A4/9X, 25(' ')/)
PRINT 85, (WEEK(J), J=1,LL)
CALL EXPAND (PAT, ARRAY, LEN, IND)
CALL COVER (ARRAY, LEN, CR, INDC)
"-----CHANGING ONE WEEK
REVISE=0
225 PRINT 230
230 FORMAT(/IX, 'SATISFIED WITH COVERAGE?')
  READ *, SAT
  IF(SAT.EQ.YES) GO TO 270
100 REVISE=REVISE+1
"-----PRINTING PATTERN
PRINT 83
83 FORMAT(/8X, 'THE PATTERN IS '/8X, 14(' ')/)
LEN=CAT(IND)
PRINT 82, (I, I=1,LEN)
82 FORMAT(7(4X, I1, 3X))
LL=CAT(IND)*7
PRINT 84, (WEEK(J), J=1,LL)
PRINT 84, ((PAT(I,J,IND), J=1,7), I=1,LEN)
PRINT 240

```

```

240 FORMAT(/IX, 'CHANGE WHICH WEEK?'/)
  READ *, WKNO
  PRINT 250
250 FORMAT(/IX, 'REVISION FOR THAT WEEK?'/)
  "-----READING REVISION
  READ *, REV
  DO 255 J=1,7
    IF (REV(J).EQ.0) REV(J)=0H
    IF (REV(J).EQ.1) REV(J)=ROT(1)
    IF (REV(J).EQ.2) REV(J)=ROT(2)
    IF (REV(J).EQ.3) REV(J)=ROT(3)
  255 CONTINUE
  DO 260 M=1,7
260 PAT(WKNO,M,IND)=REV(M)
  "-----PRINTING REVISION
  PRINT 265,REVISE
  265 FORMAT(/9X, 'REVISION NUMBER',I3)
  PRINT 78,LEN,KIND(IND)
  PRINT 85,(WEEK(J),J=1,LL)
  CALL EXPAND(PAT,ARRAY,CAT(IND),IND)
  CALL COVER(ARRAY,CAT(IND),CR,IND)
  GO TO 225
270 CONTINUE
  "-----PERMANENT SHIFT STAFF
  PRINT 280
280 FORMAT(/IX, 'ANY PERMANENT SHIFT STAFF?'/)
  READ *, PERM
  IF (PERM.NE.YES) GO TO 305
284 CALL SPARE(PS,CAT(IND),WEEK,CS,IND)
  PRINT 283
283 FORMAT(/IX, 'SATISFIED WITH THE PERMANENT SHIFT SCHEDULE
?'/)
  READ *, PARM
  IF (PARM.NE.YES) GO TO 284
  DO 285 J=1,3
  DO 285 K=1,LL
285 CRT(J,K,4)=CS(J,K)+CRT(J,K,4)
  "-----PRINTING OUTPUT REPORT
305 PRINT 300
300 FORMAT(/IX, 'FULL REPORT ON TIME SCHEDULE?'/)
  READ *, OUT
  IF (OUT.NE.YES) GO TO 310
  CALL OUTPUT(ARRAY,LEN,WEEK,PS,KIND,PERM,IND,&310)
  310 CONTINUE
  "-----INSERTING COVERAGE FOR PATTERN(RN,NI,NA)
  DO 320 J=1,3
  DO 320 K=1,LL
320 CRT(J,K,IND)=CR(J,K)+CRT(J,K,IND)+CRT(J,K,4)
  IF (OUT.NE.YES) GO TO 390
  IF (PERM.NE.YES) GO TO 351
  "-----PRINTING TOTAL COVERAGE E
  PRINT 335,KIND(IND)
335 FORMAT(/IX, 'TOTAL COVERAGE ',A4, ' AND SHIFT STAFF' /IX
,35(' ')/)

```



```

PRINT 337,(WEEK(J),J=1,LL)
337 FORMAT(9X,7(1X,7A1))
DO 340 M=1,3
340 PRINT 350,ROT(M),(CRT(M,N,IND),N=1,LL)
350 FORMAT((8X,A1,7(1X,7I1)))
"-----RETURNING TO SUBROUTINE OUTPUT
351 CALL SUB2(ARRAY)
GO TO 390
354 IF(IND.EQ.3) GO TO 355
PRINT 95
95 FORMAT(/IX,'SCHEDULE ANOTHER CATEGORY OF STAFF?'/)
READ *,ANS
IF(ANS.EQ.YES) GO TO 15
355 PRINT 370
370 FORMAT(/IX,'SATISFIED WITH THE COMPLETE SCHEDULE?'/)
READ *,ANSS
IF (ANSS.EQ.YES) GO TO 440
PRINT 380
380 FORMAT(/IX,'CHANGE WHICH STAFF CATEGORY?'/)
READ *,IND
"-----ZEROING CRT
DO 382 N=1,3
DO 382 K=1,LL
CRT(N,K,IND)=0
382 CRT(N,K,4)=0
REVISE=0
GO TO 100
"-----TOTAL COVERAGE FOR COMPLETE SCHEDULE
390 CONTINUE
IF(OUT.NE.YES) PRINT 395
395 FORMAT(/28('*'),'SUMMARY REPORT',28('*'))//)
IF(INDIC.GT.IND) IND=INDIC
IF(IND.EQ.1) PRINT 405,IND
405 FORMAT(/IX,'TOTAL COVERAGE FOR ',11,' CATEGORY OF STAFF',
/IX,38('-'))/
IF(IND.EQ.1) GO TO 406
PRINT 400,IND
400 FORMAT(/IX,'TOTAL COVERAGE FOR ',11,' CATEGORIES OF ST
AFF'/IX,41('-'))/
406 DO 410 M=1,3
DO 410 N=1,LL
410 CRT(M,N,4)=0
"-----SEARCH FOR MAXIMUM LENGTH PATTERN
MAX=0
DO 402 K=1,3
IF (CAT(K).GT.MAX) MAX=CAT(K)
402 CONTINUE
"-----TALLING COVERAGE SO FAR
LL=MAX*7
DO 420 M=1,IND
DO 420 L=1,3
SOMA=CAT(M)*7
SOME=SOMA
KK=1

```

```

DO 420 K=1,LL
IF(SOME.GE.K) GO TO 415
KK=1
SOME=SOME+SOMA
415 CRT(L,K,4)=CRT(L,K,4)+CRT(L,KK,M)
420 KK=KK+1
"-----PRINTING TOTAL COVERAGE SO FAR
PRINT 337,(WEEK(J),J=1,LL)
DO 430 M=1,3
430 PRINT 350,ROT(M),(CRT(M,N,4),N=1,LL)
RUN=RUN+1
PRINT 435,RUN
DO 432 N=1,3
DO 432 K=1,LL
432 CRT(N,K,4)=0
435 FORMAT(/IX,'END OF RUN ',11/IX,12(' - ')/70('*')//)
INDIC=IND
GO TO 354
440 PRINT 360
360 FORMAT(/IX,'SO LONG,SEE YOU NEXT TIME!')
END
"-----SUBROUTINE TO EXPAND PATTERN
SUBROUTINE EXPAND(P,A,LG,POS)
IMPLICIT INTEGER(A-Z)
DIMENSION P(7,7,3),A(7,49,3),S(1,7)
LL3=1
DO 10 LL1=1,LG
DO 10 LL2=1,7
A(1,LL3,POS)=P(LL1,LL2,POS)
10 LL3=LL3+1
L=LG-1
DO 100 I=1,L
LEG=LG
DO 50 J=1,7
50 S(1,J)=P(LG,J,POS)
DO 60 M=2,LG
DO 55 N=1,7
55 P(LEG,N,POS)=P(LEG-1,N,POS)
60 LEG=LEG-1
DO 70 K=1,7
70 P(1,K,POS)=S(1,K)
LL3=1
DO 82 LL1=1,LG
DO 82 LL2=1,7
A(1+1,LL3,POS)=P(LL1,LL2,POS)
82 LL3=LL3+1
100 CONTINUE
LL=LG*7
DO 120 I=1,LG
120 PRINT 105,1,(A(1,J,POS),J=1,LL)
105 FORMAT((4X,12,3X,7(1X,7A1)))
Z=1
DO 110 I=1,LG
DO 110 J=1,7

```

```
P(1,J,POS)=A(1,Z,POS)
```

```
110 Z=Z+1
```

```
RETURN
```

```
END
```

```
"-----SUBROUTINE TO TOTAL COVERAGE DAY,EVENING,NIGHT
```

```
SUBROUTINE COVER(AA,LENG,CC,PLA)
```

```
IMPLICIT INTEGER(A-Z)
```

```
DIMENSION AA(7,49,3),C(3),CC(3,49),ROT(3)
```

```
DATA ROT/'D','E','N'/'
```

```
END=LENG*7
```

```
DO 5 I=1,3
```

```
DO 5 J=1,END
```

```
5 CC(I,J)=0
```

```
DO 20 J=1,END
```

```
C(1)=0
```

```
C(2)=0
```

```
C(3)=0
```

```
DO 10 I=1,LENG
```

```
DO 10 K=1,3
```

```
IF(AA(I,J,PLA).EQ.ROT(K)) C(K)=C(K)+1
```

```
10 CONTINUE
```

```
DO 15 L=1,3
```

```
15 CC(L,J)=C(L)
```

```
20 CONTINUE
```

```
DO 40 M=1,3
```

```
40 PRINT 30,ROT(M),(CC(M,N),N=1,END)
```

```
30 FORMAT((8X,A1,7(1X,711)))
```

```
RETURN
```

```
END
```

```
"-----SUBROUTINE FOR PRINTING OUTPUT
```

```
SUBROUTINE OUTPUT(A1,LENGTH,WK,PPP,TYPE,PER,MMM,*)
```

```
IMPLICIT INTEGER(A-Z)
```

```
DIMENSION A1(7,49,3),WK(49),C(3,49),PPP(7,49,3),STR(14),TYPE
```

```
(3)
```

```
DATA OH,DAY,EVEN,NIGHT,YES,STR/'X','D','E','N','YES',14*0/
```

```
V1=0
```

```
V2=0
```

```
V3=0
```

```
V4=0
```

```
TL=LENGTH*7
```

```
PRINT 5,TYPE(MMM)
```

```
5 FORMAT(/70('*'))/20X,'FULL REPORT FOR ',A4/20X,20(' '=')/)
```

```
"-----PRINTING SCHEDULE
```

```
IF(PER.NE.YES) GO TO 4
```

```
CALL SUB1(PPP,WK,MMM)
```

```
4 PRINT 6,LENGTH,TYPE(MMM)
```

```
6 FORMAT(/1X,'SHIFT SCHEDULE FOR',1X,11,1X,A4/1X,25(' '-')/)
```

```
PRINT 10,(WK(J),J=1,TL)
```

```
10 FORMAT(1X,'EMPLOYEE',7(1X,7A1))
```

```
DO 20 I=1,LENGTH
```

```
20 PRINT 25,1,(A1(I,J,MMM),J=1,TL)
```

```
25 FORMAT((4X,12,3X,7(1X,7A1)))
```

```
CALL COVER(A1,LENGTH,C,MMM)
```

```
RETURN 1
```

"-----FINDING MAXIMUM AND MINIMUM WORK STRETCH

ENTRY SUB2(A1)

KK=0

COUNT=0

CHECK=0

DO 30 J=1,TL

IF(A1(1,J,MMM).NE.OH) GO TO 28

CHECK=CHECK+1

IF(CHECK.GT.1) GO TO 30

IF(COUNT.EQ.0) GO TO 30

KK=KK+1

STR(KK)=COUNT

COUNT=0

GO TO 30

28 COUNT=COUNT+1

CHECK=0

30 CONTINUE

N=1

"-----SEARCHING FOR MIN AND MAX

IF(A1(1,TL,MMM).EQ.OH) GO TO 36

IF(A1(1,1,MMM).EQ.OH) GO TO 34

KK=KK+1

STR(KK)=COUNT

STR(1)=STR(1)+STR(KK)

KK=KK-1

N=1

GO TO 36

34 KK=KK+1

STR(KK)=COUNT

N=1

36 MIN=99

MAX=-99

DO 37 J=N, KK

IF(STR(J).LT.MIN) MIN=STR(J)

IF(STR(J).GT.MAX) MAX=STR(J)

37 CONTINUE

38 PRINT 35,TYPE(MMM)

35 FORMAT(/IX,'FULL REPORT ON SCHEDULE FOR ',A4/IX,32(' '))

PRINT 40,MIN,MAX

40 FORMAT(/IX,'MINIMUM WORK STRETCH =',I2//IX,'MAXIMUM WORK STRETCH =',I2/)

"----- TOTAL D,E,N SHIFTS FOR PERSONNEL

D=0

E=0

N=0

DO 50 J=1,TL

IF(A1(1,J,MMM).EQ.DAY) D=D+ 1

IF(A1(1,J,MMM).EQ.EVEN) E=E+ 1

IF(A1(1,J,MMM).EQ.NIGHT) N=N+1

50 CONTINUE

PRINT 60,D,E,N

60 FORMAT(IX,'TOTAL DAY SHIFTS =',I2//IX,'TOTAL EVENING SHIFTS =',I2//IX,'TOTAL NIGHT SHIFTS =',I2/)

WD=D+E+N

```

PRINT 65,WD
65 FORMAT(1X,'TOTAL NUMBER OF WORKDAYS =',12/)
"-----TOTAL NUMBER OF SPLIT DAYS OFF
SPLIT=0
TL1=TL-1
DO 70 J=2,TL1
IF(A1(1,J,MMM).NE.OH) GO TO 70
IF(A1(1,J-1,MMM).EQ.OH) GO TO 70
IF(A1(1,J+1,MMM).NE.OH) SPLIT=SPLIT+1
70 CONTINUE
IF(A1(1,TL,MMM).NE.OH) GO TO 72
IF(A1(1,TL-1,MMM).EQ.OH) GO TO 72
IF(A1(1,1,MMM).NE.OH) SPLIT=SPLIT+1
72 CONTINUE
IF(A1(1,1,MMM).NE.OH) GO TO 74
IF(A1(1,TL,MMM).EQ.OH) GO TO 74
IF(A1(1,2,MMM).EQ.OH) GO TO 74
IF(A1(1,TL,MMM).NE.OH) SPLIT=SPLIT+1
74 PRINT 80,SPLIT
80 FORMAT(1X,'NUMBER OF SPLIT DAYS OFF =',12/)
"-----NO OF WEEKENDS OFF
WE=0
DO 90 J=1,TL,7
IF(A1(1,J+5,MMM).NE.OH) GO TO 90
IF(A1(1,J+6,MMM).EQ.OH) WE=WE+1
90 CONTINUE
PRINT 100,LENGTH,WE
100 FORMAT(1X,'NUMBER OF WEEKENDS OFF IN',12,1X,'=' ,12/)
"-----VOIATIONS
"-----N OR E SHIFT ON FRI BEFORE SS OFF
PRINT 102
102 FORMAT(/1X,'VOIATIONS'/1X,10('*')/)
DO 110 J=1,TL,7
IF(A1(1,J+5,MMM).NE.OH) GO TO 110
IF(A1(1,J+6,MMM).NE.OH) GO TO 110
IF(A1(1,J+4,MMM).EQ.NIGHT) V1=V1+1
IF(A1(1,J+4,MMM).EQ.EVEN) V1=V1+1
110 CONTINUE
PRINT 120,V1
120 FORMAT(/1X,'NUMBER OF TIMES EVENING OR NIGHT SHIFT BEFO
RE WEEKEND OFF =',12/)
"-----E-D SHIFT AND E-N SHIFT
DO 130 J=1,TL1
IF(A1(1,J,MMM).EQ.EVEN) GO TO 125
GO TO 130
125 IF(A1(1,J+1,MMM).EQ.DAY) V2=V2+1
IF(A1(1,J+1,MMM).EQ.NIGHT) V3=V3+1
130 CONTINUE
IF(A1(1,TL,MMM).NE.EVEN) GO TO 131
IF(A1(1,1,MMM).EQ.DAY) V2=V2+1
IF(A1(1,1,MMM).EQ.NIGHT) V3=V3+1
131 CONTINUE
"-----N-D SHIFT
DO 134 J=1,TL1

```

```

IF(AI(1,J,MMM),NE,NIGHT) GO TO 134
IF(AI(1,J+1,MMM).EQ,DAY) V4=V4+1
134 CONTINUE
IF(AI(1,TL,MMM).NE,NIGHT) GO TO 132
IF(AI(1,TL,MMM).EQ,DAY) V4=V4+1
132 PRINT 140,V2,V3,V4
140 FORMAT(1X,'NUMBER OF TIMES EVENING-DAY SHIFT =',12//1X,
'NUMBER OF TIMES EVENING-NIGHT SHIFT =',12//1X,'NUMBER OF TI
MES NIGHT-DAY SHIFT =',12/)
RETURN
END
"-----SUBROUTINE FOR PERMANENT-PART TIME STAFF
SUBROUTINE SPARE(T,LIM,W,CT,SP)
  IMPLICIT INTEGER(A-Z)
  DIMENSION T(7,49,3),W(49),CT(3,49),NUMB(3),ROT(3)
  DATA YES,ROT,OH/'YES','D','E','N','X'/
  LIMIT=LIM*7
  PRINT 5
  5 FORMAT(/1X,'HAVE YOU SCHEDULED THEM BEFORE?'/)
  READ *,ANS
  IF(ANS.EQ.YES) GO TO 70
  PRINT 10
  10 FORMAT(/1X,'HOW MANY PERMANENT SHIFT STAFF?'/)
  READ *,NUMB(SP)
  PRINT 20,LIM,NUMB(SP)
  20 FORMAT(/1X,'PLEASE ENTER ',11,'-WEEK SHIFT STAFF PATTERN
FOR ',11,' PERMANENT SHIFT STAFF.'/)
  NUM=NUMB(SP)
  READ *,((T(I,J,SP),J=1,LIMIT),I=1,NUM)
  DO 22 I=1,NUM
  DO 22 J=1,LIMIT
  IF(T(I,J,SP).EQ.0) T(I,J,SP)=OH
  IF(T(I,J,SP).EQ.1) T(I,J,SP)=ROT(1)
  IF(T(I,J,SP).EQ.2) T(I,J,SP)=ROT(2)
  IF(T(I,J,SP).EQ.3) T(I,J,SP)=ROT(3)
  22 CONTINUE
  ENTRY SUBI(T,W,SP)
  PRINT 25,NUMB(SP),(W(J),J=1,LIMIT)
  NUM=NUMB(SP)
  DO 40 I=1,NUM
  40 PRINT 30,I,(T(I,J,SP),J=1,LIMIT)
  30 FORMAT((4X,12,3X,7(1X,7A1)))
  25 FORMAT(/1X,'SCHEDULE FOR ',11,' PERMANENT SHIFT STAFF'/1X
,36(' ')//1X,'EMPLOYEE',7(1X,7A1))
  IF(NUM.EQ.7) GO TO 60
  BEG=NUM+1
  DO 57 I=BEG,7
  DO 57 J=1,LIMIT
  57 T(I,J,SP)=0
  GO TO 60
  70 PRINT 50
  50 FORMAT(/1X,'OKAY,LET'S LOOK AT THE PERMANENT SHIFT SCHED
ULE AGAIN!'/)
  PRINT 55

```

```
55 FORMAT(/10X, 'PREVIOUS PERMANENT STAFF SCHEDULE' /10X, 33( '-  
' ) / )  
NUM=NUMB(SP)  
PRINT 52, (W(J), J=1, LIMIT)  
52 FORMAT(/1X, 'EMPLOYEE', 7(1X, 7A1))  
DO 56 I=1, NUM  
56 PRINT 30, I, (T(I, J, SP), J=1, LIMIT)  
60 CALL COVER(T, LIM, CT, SP)  
RETURN  
END
```

"NURSE 3" PROGRAM



-----WORK SCHEDULE PROJECTOR-----

PARTIAL LIST PROGRAM VARIABLES

ARRAY(42)	OUTPUT ARRAY OF SHIFTS
BEFORE	INDICATOR
CC(3,42)	COVERAGE ARRAY
DAYS(12)	ARRAY OF DAYS OF EACH MONTH
DAY	DAY OF MONTH
DWK	DAY OF WEEK SCHEDULE STARTS
FIRST	DAY OF WEEK MONTH STARTS ON
FS1(42)	ARRAY OF SHIFTS
GAMA	INDICATOR
HOLD	OUTPUT ARRAY OF NUMBERS
IND	INDICATOR
INDC	INDICATOR
LEN	PATTERN LENGTH IN WEEKS
LIM	PATTERN LENGTH IN DAYS
MANY	INDICATOR
MO	MONTH NUMBER
MONTH(12)	ARRAY OF MONTH NAMES
NAME1(21)	FIRST NAMES OF EMPLOYEES
NAME2(21)	LAST NAMES OF EMPLOYEES
NEWNO	DAY NUMBER OF NEW SCHEDULE
NIMB(31)	ARRAY OF NUMBERS
OVER(3,42)	OVERFLOW IN COVERAGE
PAT(49)	ARRAY OF WORK PATTERNS
PATT(21,49)	STORAGE FOR PATTERNS
PL(21)	PATTERN LENGTHS
PROJ(366)	YEAR'S PROJECTION OF SCHEDULE
RE	INDICATOR
REM	INDICATOR
RQT(9)	CODE ARRAY
S(42)	OUTPUT ARRAY
SAVE(21,42)	OUTPUT ARRAY
STATUS(21)	STATUS OF EACH EMPLOYEE
TE	END OF MONTH
UNIT	NAME OF UNIT
WEEK(7)	DAYS OF WEEK
XX	INDICATOR
YR	YEAR SCHEDULE ENDS

IMPLICIT INTEGER(A-Z)

INTEGER\*2 STATUS(21)

REAL\*8 NAME2(21),UNIT,HN2,WC 2

DIMENSION WEEK(7),MONTH(12),DAYS(12),ARRAY(42),HOLD(42),NUM  
B(31),SAVE(21,42),S(42),C(3),CC(3,42),ROT(9),OVER(3,42),FS1(42)

DIMENSION PL(21),PATT(21,49),PAT(49),PROJ(366),NAME1(21),TOP  
(42),BOT(42),NUMBER(10)

DATA SEPT,APR,JUN,NOV,JAN,MAR,MAY,JULY,AUG,OCT,DEC,FEB,OVER

1/-

4\*30,7\*31,28,0/

DATA WEEK,MONTH/'S','M','T','W','T','F','S','JAN','FEB',-  
'MAR','APR','MAY','JUNE','JULY','AUG','SEPT','OCT','NOV','DE  
C'/

DATA DAYS,YES,BLA,SAVE/31,28,31,30,31,30,31,31,30,31,30,31,  
'YES',' ',882\*'/

DATA NUMB/'1','2','3','4','5','6','7','8','9','10',  
'11','12','13','14','15','16','17','18','19','20','21','22',  
'23','24','25','26','27','28','29','30','31'/

DATA ROT,OH,NUMBER,EE/'D','E','N','A','R','S','O','T','C','X',  
'0','1','2','3','4','5','6','7','8','9','1'/

PRINT 5

5 FORMAT(/9X,46('\*')/9X,'\*',44X,'\*/9X,'\*',44X,'\*/9X,'\*',

12X,'THE GENERAL HOSPITAL',12X,'\*/9X,'\*',44X,'\*/9X,'\*',-  
3X,'WELCOME TO THE WORK SCHEDULE PROJECTOR',3X,'\*/9X,'\*',-  
44X,'\*/9X,'\*',44X,'\*/9X,46('\*')//)

PRINT 2

2 FORMAT(/1X,'DO YOU WANT INFORMATION ON HOW TO USE THE PR  
OGRAM?-

'//1X,'ANSWER YES OR NO ENCLOSED IN SINGLE QUOTES.'/)

READ \*,INFORM

IF (INFORM.NE.YES) GO TO 6

PRINT 3

3 FORMAT(/70('\*')//1X,'INFORMATION'/1X,11('\*')//1X,-  
'PURPOSE - '//9X,'TO PRINT:- (1) INDIVIDUAL SCHEDULES AND (2)  
UNIT -

SCHEDULE '//9X,'OVER A PERIOD OF TIME.'//1X,'INPUT - '//7X,'(1  
) THE -

WORK PATTERNS FOR EACH STAFF MEMBER AS FINALIZED'//11X,'IN -  
"NURSE2" PROGRAM.'//7X,'(2) CALENDAR AND FILE INFORMATION.'//  
/1X,'OPERATION -'

//11X,'THE PROGRAM PROJECTS WORK SCHEDULES OVER A GIVEN PERI  
OD'//11X,'OF -

TIME.'//1X,'DETAILS - '//9X,'ANSWER YES OR NO IN SINGLE QUOTE  
S UNLESS -

SPECIFIED OTHERWISE.'//9X,'MONTH ----- NUMBER OF MONTH.  
EG,-

11'//9X,'DAY OF MONTH --- NUMBER. EG. 22'//9X,'DAY OF WEEK  
---- NUMBER. IE. 1 2 3 4 5 6 7'//36X,-

' S M T W T F S'//36X,'EG. SUN WOULD BE 1'//9X,'NAMES ---  
-----

- FIRST - MAXIMUM OF 4 LETTERS. EG. 'JUDY'//24X,-

- LAST -- MAXIMUM OF 8 LETTERS. EG. 'SHEPPARD'//

//9X,'STATUS ----- MAXIMUM OF 2 LETTERS. EG. 'RN'//

//9X,'PATTERN LENGTH - IN WEEKS. EG. 4'//9X,'PATTERN CODE---  
- SAME AS IN "NURSE2" PROGRAM.-

//9X,'NAME OF UNIT --- MAXIMUM OF 8 LETTERS. -

EG. '2-S WARD'//1X,'LIMITS - '//8X,'MAXIMUM FORECAST FOR A  
NY -

SCHEDULE = 12 MONTHS'//8X,'MAXIMUM NUMBER OF STAFF SCHEDULED  
IN ONE RUN = 21'//70('\*')//)

"-----READING SCHEDULE FROM DISK

"-----SET UP FOR 4 UNITS

6 CONTINUE

```

DEFINE FILE 8(84,60,E,1D1)
P=1
PRINT 7
7 FORMAT(/IX, 'NEW FILE?'/)
READ *,NFILE
IF(NFILE.EQ.YES) GO TO 8
PRINT 11
11 FORMAT(/IX, 'FILE NUMBER & NUMBER EMPLOYEES?'/)
READ *,FILEN,NEMP
P=(FILEN-1)*21+1
READ (8,P,14) (FILEN,NAME1(1),NAME2(1),STATUS(1),(SAVE(1,J)
,J=1,42),-
I=1,NEMP)
14 FORMAT((14,A4,A8,A2,6(7A1)))
GO TO 402
8 PRINT 9
9 FORMAT(/IX, 'FILE NUMBER?'/)
READ *,FILEN
P=(FILEN-1)*21+1
PRINT 10
10 FORMAT(/IX, 'WHAT MONTH, DAY OF MONTH, AND DAY OF THE WEEK
DO WE START -
PATTERN?'/)
READ *,MO, DAY, DWK
MOO=MO
DAY1=DAY
DAWK1=DWK
PRINT 70
70 FORMAT(/IX, 'WHAT DAY OF THE WEEK DOES MONTH START ON?'/)
READ *,FIRST
FIRST1=FIRST
PRINT 25
25 FORMAT(/IX, 'IS THIS A LEAP YEAR?'/)
READ *,ANS
23 IND=0
24 PRINT 26
26 FORMAT(/IX, 'EMPLOYEE'S NAME AND STATUS?'/)
"-----SAVING INPUT
MANY=0
SIX=42
MO=MOO
DAY=DAY1
DWK=DAWK1
FIRST=FIRST1
IND=IND+1
READ *,NAME1(IND),NAME2(IND),STATUS(IND)
PRINT 20
20 FORMAT(/IX, 'PATTERN LENGTH?'/)
READ *,LEN
LIM=LEN*7
PL(IND)=LEN
PRINT 22
22 FORMAT(/IX, 'PATTERN?'/)
READ *,(PAT(J),J=1,LIM)

```

```

"-----CONVERTING CODE TO D E N SHIFTS
DO 21 J=1,LIM
IF(PAT(J).EQ.0) PAT(J)=0H
DO 21 K=1,9
IF(PAT(J).EQ.K) PAT(J)=ROT(K )
21 CONTINUE
"-----SAVING PATTERN
DO 27 J=1,LIM
27 PATT(IND,J)=PAT(J)
PRINT 12
12 FORMAT(/IX,'PRINT THE INDIVIDUAL SCHEDULE?'/)
READ *,INDC
IF(INDC.NE.YES) GO TO 17
PRINT 15
15 FORMAT(/IX,'FOR HOW MANY MONTHS?'/)
READ *,MANY
MANY=MANY-1
17 CONTINUE
IF(ANS.EQ.YES) GO TO 28
FINAL=365
"-----GETTING LAST DAY OF MONTH
GO TO (40,50,40,30,40,30,40,40,30,40,30,40),MO
28 CONTINUE
FINAL=366
GO TO (40,55,40,30,40,30,40,40,30,40,30,40),MO
30 TE=30
GO TO 60
40 TE=31
GO TO 60
50 TE=28
GO TO 60
55 TE=29
60 CALL YEAR(PAT,PROJ,TE,DAY,LEN,ANS)
SVTE=TE
SVDAY=DAY
SVANS=ANS
"-----SAVING SCHEDULE FOR UNIT
DO 76 J=1,42
76 SAVE(IND,J)=PROJ(J)
IF(INDC.NE.YES) GO TO 189
"-----PRINTING PATTERNS
SS=DAYS(MO)-(7-FIRST+1)
RE=7-MOD(SS,7)
"-----FILLING FIRST WEEK WITH BLANKS
XX=DAY-2+FIRST
DO 80 I=1,XX
80 ARRAY(I)=BLA
NUM=DAYS(MO)
"-----FILLING IN SHIFTS
N=1
YY=XX+1
DO 90 I=DAY,NUM
ARRAY(YY)=PROJ(N)
YY=YY+1

```

```

90 N=N+1
DO 92 I=1,RE
ARRAY(YY)=BLA
92 YY=YY+1
"-----PRINTING FIRST MONTH
PRINT 95,NAME1(IND),NAME2(IND),STATUS(IND)
95 FORMAT(//19X,35('*')/19X,'*',2X,'SCHEDULE FOR ',A4,1X,A
8,1X,A2,2X,'*'/19X,35('*'))
PRINT 100,MONTH(MO)
100 FORMAT(//14X,45(' ')14X,'1',18X,'1',1X,A4,1X,'1',17X,'1
',/14X,'1',43(' '),1')
"-----PUTTING NUMBERS IN ARRAY
XX=FIRST-1
DO 110 I=1,XX
110 HOLD(I)=BLA
Y=XX+1
DO 120 J=1,NUM
HOLD(Y)=NUMB(J)
120 Y=Y+1
DO 122 I=1,RE
HOLD(Y)=BLA
122 Y=Y+1
PRINT 125,(WEEK(J),J=1,7)
125 FORMAT(14X,'1',3X,A2,2X,5(2X,A2,2X),2X,A2,2X,'1'/14X,'1
',43(' '),1')
126 FORMAT(14X,'1',3X,A2,2X,5(2X,A2,2X),2X,A2,2X,'1')
L=NUM+FIRST
K=1
DO 135 I=1,6
KK=K+6
IF(KK.GE.L) KK=L+RE-1
PRINT 138,(HOLD(J),J=K,KK)
PRINT 126,(ARRAY(JJ),JJ=K,KK)
IF(KK.GE.L) GO TO 139
135 K=K+7
138 FORMAT(14X,'1',2X,A2,2X,6(2X,A2,2X),1X,'1')
139 PRINT 137
137 FORMAT(14X,45(' '))
"-----PRINTING REMAINING MONTHS
SSS=DAYS(MO)-(7-FIRST+1)
COUNT=DAYS(MO)-DAY+2
REM=MOD(SSS,7)
IF(MANY.EQ.0) GO TO 180
"-----LOOP TO PRINT REMAINING MONTHS
DO 180 M=1,MANY
MO=MO+1
IF(MO.GT.12) MO=1
SS=DAYS(MO)-(7-REM)
RE=7-MOD(SS,7)
NUM=DAYS(MO)
"-----FIRST WEEK
DO 140 I=1,REM
140 ARRAY(I)=BLA
YY=REM+1

```

```

"-----FILLING IN SHIFTS
DO 150 J=1,NUM
  ARRAY(YY)=PROJ(COUNT)
  COUNT=COUNT+1
  150 YY=YY+1
DO 155 HL=1,RE
  ARRAY(YY)=BLA
  155 YY=YY+1
"-----PRINTING MONTH
  PRINT 100,MONTH(MO)
"-----FILLING IN NUMBERS
DO 160 K=1,REM
  160 HOLD(K)=BLA
  Y=REM+1
DO 170 N=1,NUM
  HOLD(Y)=NUMB(N)
  170 Y=Y+1
DO 172 HF=1,RE
  HOLD(Y)=BLA
  172 Y=Y+1
END=NUM+REM
  PRINT 125,(WEEK(JL),JL=1,7)
  K1=1
  IF(RE.EQ.7) RE=0
  DO 175 H=1,6
    K2=K1+6
    IF(K2.GE.END) K2=END+RE
    PRINT 138,(HOLD(J1),J1=K1,K2)
    PRINT 126,(ARRAY(JJ),JJ=K1,K2)
    IF(K2.GE.END) GO TO 176
    175 K1=K1+7
  176 PRINT 137
  FIRST=MOD(END,7)+1
  180 REM=FIRST-1
  189 PRINT 190
  190 FORMAT(/IX,'SCHEDULE ANOTHER PERSON?'/)
  READ *,SCHED
  IF(SCHED.EQ.YES) GO TO 24
  203 PRINT 200
  200 FORMAT(/IX,'UNIT NAME?'/ )
  READ *,UNIT
  PRINT 204
  204 FORMAT(/IX,'NAMES OF HEAD NURSE AND WARD CLERK?'/)
  READ *,HN1,HN2,WC1,WC2
  KK=1
  DO 201 I=1,6
    DO 201 J=1,7
      FS1(KK)=ROT(I)
      IF(J.GE.6) FS1(KK)=OH
      201 KK=KK+1
"-----HEADING
  PRINT 205
  205 FORMAT(/IX,'WHAT MONTH,DAY OF MONTH AND DAY OF WEEK DOE
S -

```

```

SCHEDULE START? '/')
  READ *,M1,D1,DWK2
  IF(DWK2.EQ.1) GO TO 206
  "-----HEADING
  DO 206 I=1,42
  S(1)=WEEK(DWK2)
  DWK2=DWK2+1
  IF(DWK2.GT.7) DWK2=1
  206 CONTINUE
  PRINT 207
  207 FORMAT(/IX, 'WHAT MONTH, DAY OF MONTH AND YEAR DOES SCHED
  ULE-
  END ?')
  READ *,M2,D2,YR
  INDA=0
  IF((M2-M1).EQ.2) INDA=1
  IF(ABS(M2-M1).EQ.10) INDA=1
  "-----BOTTOM OF MONTH HEADING
  EXIT=DAYS(M1)
  X=1
  DO 208 I=D1,EXIT
  NA=MOD(I,10)
  BOT(X)=NUMBER(NA+1)
  IF(I.LT.10) BOT(X)=NUMBER(I+1)
  208 X=X+1
  IF(INDA.NE.1) GO TO 213
  NEXIT=DAYS(M1+1)
  DO 211 I=1,NEXIT
  NA=MOD(I,10)
  BOT(X)=NUMBER(NA+1)
  IF(I.LT.10) BOT(X)=NUMBER(I+1)
  211 X=X+1
  213 DO 209 I=1,D2
  NA=MOD(I,10)
  BOT(X)=NUMBER(NA+1)
  IF(I.LT.10) BOT(X)=NUMBER(I+1)
  209 X=X+1
  "-----TOP OF MONTH HEADING
  X=1
  DO 215 J=D1,EXIT
  IF(J.LT.32) TOP(X)=NUMBER(4)
  IF(J.LT.30) TOP(X)=NUMBER(3)
  IF(J.LT.20) TOP(X)=NUMBER(2)
  IF(J.LT.10) TOP(X)=BLA
  215 X=X+1
  IF(INDA.NE.1) GO TO 218
  DO 216 J=1,NEXIT
  IF(J.LT.32) TOP(X)=NUMBER(4)
  IF(J.LT.30) TOP(X)=NUMBER(3)
  IF(J.LT.20) TOP(X)=NUMBER(2)
  IF(J.LT.10) TOP(X)=BLA
  216 X=X+1
  218 DO 217 J=1,D2
  IF(J.LT.32) TOP(X)=NUMBER(4)

```

```

IF(J.LT.30) TOP(X)=NUMBER(3)
IF(J.LT.20) TOP(X)=NUMBER(2)
IF(J.LT.10) TOP(X)=BLA
217 X=X+1
221 PRINT 295,FILEN,IND
295 FORMAT(/IX,'FILE NUMBER =',12,5X,'NUMBER OF EMPLOYEES =',
12)
PRINT 210,MONTH(M1),D1,MONTH(M2),D2,YR,UNIT,TOP,BOT
210 FORMAT(/IX,71('- ')/IX,'1',69X,'1'/IX,'1',69X,-
'1'/IX,'1',23X,'THE GENERAL HOSPITAL',24X,'1'/IX,'1',69X,-
'1'/IX,'1',23X,'SIX WEEK TIME SCHEDULE',24X,-
'1'/IX,'1',23X,22('- '),24X,'1'/IX,'1',69X,'1'/IX,'1',69X,'1'
/-
IX,'1',IX,'DATE: ',IX,A4,IX,12,' - ',A4,IX,12,IX,'19',12,24X
,-
'UNIT:',IX,A8,IX,'1'/IX,'1',69X,'1'/IX,'1',20X,6(IX,7A1),IX,
'1'/IX,'1',20X,6(IX,7A1),IX,'1')
PRINT 212,S,HN1,HN2,FS1
212 FORMAT(IX,'1',69('- '),'1'/IX,'1',IX,'DAY OF MONTH',5X,'1'
,IX,6(IX,7A1),IX,'1'/IX,'1',69('- '),'1'/IX,'1',IX,'NAME',6X
,'STATUS',IX,'1',50X,'1'/IX,'1',18X,'1',50X,'1'/IX,'1',IX,A4
,IX,A8,IX,'HN',IX,'1',1X,6(IX,7A1),IX,'1')
"-----PRINTING SCHEDULE FOR UNIT
DO 220 J=1,IND
IF(J.EQ.1) PRINT 235
IF(J.EQ.1) GO TO 220
IF(STATUS(J).NE.STATUS(J-1)) PRINT 235
235 FORMAT(IX,'1',18X,'1',50X,'1')
220 PRINT 230,NAME1(J),NAME2(J),STATUS(J),(SAVE(J,K),K=1,42)
230 FORMAT(IX,'1',IX,A4,IX,A8,IX,A2,IX,'1',IX,6(IX,7A1),IX,'
1'/IX,'1',18X,'1',50X,'1')
PRINT 232,WC1,WC2,FS1
232 FORMAT(IX,'1',IX,A4,IX,A8,IX,'WC',IX,'1',IX,6(IX,7A1),IX
,'1'/IX,'1',18X,'1',50X,'1')
"-----COVERAGE DAY,EVENING,NIGHT
END=42
DO 240 I=1,3
DO 240 J=1,END
240 CC(I,J)=0
DO 260 J=1,END
C(1)=0
C(2)=0
C(3)=0
DO 250 I=1,IND
DO 250 K=1,3
IF(SAVE(I,J).EQ.ROT(K)) C(K)=C(K)+1
250 CONTINUE
DO 255 L=1,3
255 CC(L,J)=C(L)
260 CONTINUE
"-----OVERFLOW .GT. 9
DO 265 I=1,3
DO 265 J=1,42
IF(CC(I,J).GT.9) OVER(I,J)=CC(I,J)

```



```

IF(CC(1,J).GT.9) OVERI=1
OVER(1,J)=CC(1,J)
265 CONTINUE
PRINT 270,(CC(1,N),N=1,END)
270 FORMAT(1X,'1',18X,'1',50X,'1'/1X,'1',69(' '),1'/1X,'1',
1X,'COVERAGE',5X,'DAY',1X,'1',1X,6(1X,711),1X,'1')
PRINT 280,(CC(2,N),N=1,END)
280 FORMAT(1X,'1',18X,'1',50X,'1'/1X,'1',10X,'EVENING',1X,'1',
1X,6(1X,711),1X,'1')
PRINT 290,(CC(3,N),N=1,END)
290 FORMAT(1X,'1',18X,'1',50X,'1'/1X,'1',12X,'NIGHT',1X,'1',
1X,6(1X,711),1X,'1'/1X,'1',18X,'1',50X,'1'/1X,71(' '))
PRINT 292
292 FORMAT(1X,'1',1X,'CODE:-',1X,'D=DAY SHIFT',6X,'E=EVENIN
G SHIFT',-
2X,'N=NIGHT SHIFT',3X,'X=DAY OFF',2X,'1'/1X,'1',8X,'S=SICK L
EAVE',5X,-
'A=ANNUAL LEAVE',3X,'C=CLASS DAY',5X,'O=DAY OWED',1X,'1'/1X,
'1',8X,-
'T=NURSING DISTRICT',16X,'R=REQUESTED DAY OFF',8X,'1'/1X,'1',
69X,-
'1'/1X,71(' ')///)
"-----WRITING SCHEDULE ON DISK
WRITE (8'P,14) (FILEN,NAME1(1),NAME2(1),STATUS(1),(SAVE-
(1,J),J=1,42),I=1,IND)
IF(OVERI.NE.1) GO TO 402
"-----PRINTING OVERFLOW
PRINT 291,((OVER(1,J),J=1,42),I=1,3)
291 FORMAT(15X,'COVERAGE WHICH IS GREATER THAN 9 + REGULAR
COVERAGE'//1X,'DAY',1X,14(12,1X)/15X,14(12,1X)/15X,14(12,1X
)//7X,'EVENING',1X,14(12,1X)/15X,14(12,1X)/15X,14(12,1X)//9X,
'NIGHT'-
1X,14(12,1X)/15X,14(12,1X)/15X,14(12,1X)/)
"-----MAKING CHANGES TO THE UNIT SCHEDULE
402 PRINT 400
400 FORMAT(/1X,'ANY CHANGE TO THE UNIT SCHEDULE?'/)
READ *,CHANGE
IF(CHANGE.NE.YES) GO TO 450
405 PRINT 410
410 FORMAT(/1X,'CHANGE WHICH NUMBER EMPLOYEE?'/)
READ *,NOEMP
PRINT 420
420 FORMAT(/1X,'NAME & NEW 6-WEEK SCHEDULE?'/)
READ *,NAME1(NOEMP),NAME2(NOEMP),(SAVE(NOEMP,K),K=1,42)
"-----CONVERTING CODE TO D,E,N SHIFTS
DO 430 J=1,42
IF(SAVE(NOEMP,J).EQ.0) SAVE(NOEMP,J)=0H
DO 430 K=1,9
IF(SAVE(NOEMP,J).EQ.K) SAVE(NOEMP,J)=ROT(K)
430 CONTINUE
PRINT 440
440 FORMAT(/1X,'ANOTHER CHANGE?'/)

```

```

READ *,ACHAN
IF(ACHAN.EQ.YES) GO TO 405
IF(NFILE.NE.YES) IND=NEMP
IF(NFILE.EQ.YES) GO TO 221
GO TO 203
450 CONTINUE
"-----AUTOMATIC PROJECTION OF SCHEDULE
PRINT 500
500 FORMAT(/IX,'DO YOU WANT TO PROJECT THE UNIT SCHEDULE AN
OTHER SIX WEEKS?'/)
READ *,GAMA
IF(GAMA.NE.YES) GO TO 540
PRINT 502
502 FORMAT(/IX,'FILE NUMBER?'/)
READ *,FILEN
P=(FILEN-1)*21+1
EE=EE+42
DO 530 J=1,IND
LENN=PL(J)
LENG=LENN*7
EA=EE
DO 510 K=1,LENG
510 PAT(K)=PATT(J,K)
CALL YEAR(PAT,PROJ,SVTE,SVDAY,LENN,SVANS)
DO 520 L=1,42
SAVE(J,L)=PROJ(EA)
520 EA=EA+1
530 CONTINUE
GO TO 203
540 PRINT 550
550 FORMAT(/IX,'SO LONG, SEE YOU NEXT TIME!'/)
END
"-----SUBROUTINE TO FILL YEAR WITH PATTERN
SUBROUTINE YEAR(PT,PRO,END,DA,LG,LEAP)
IMPLICIT INTEGER(A-Z)
DIMENSION PT(49),PRO(366)
DATA YES,FINAL/'YES',365/
KK=1
KKK=1
N=END-DA+2
DO 10 K=DA,END
IF(KKK.GT.LG*7) KKK=1
PRO(KK)=PT(KKK)
KKK=KKK+1
10 KK=KK+1
IF(LEAP.EQ.YES) FINAL=366
DO 20 M=N,FINAL
IF(KKK.GT.LG*7) KKK=1
PRO(M)=PT(KKK)
20 KKK=KKK+1
END

```

APPENDIX B

1. Patient Classification Form.
2. Criteria for Patient Classification.

A B C D

---

Sex
Age

Sex		Age	
A1	w/o Assistance	Ambulation	Bathing
A2	w/ Assistance		
A3	Confined to bed	Feeding	Orientation
B1	Self		
B2	Partial Self	Feeding	Orientation
B3	Complete Assistance		
C1	Self	Feeding	Orientation
C2	Partial Self		
C3	Complete Assistance	Feeding	Orientation
D1	Oriented		
D2	Confused	Feeding	Orientation
D3	Disoriented		
1	Vital signs of 2 or more	Other	
2	I.V.		
3	Suction of 4 or more		
4	Oxygen		
5	Isolation		
6	Unconscious		
7	Incontinent		
8	Vision Inadequate		
Being Specialized of Necessity			
CATEGORY			
I			
II			
III			

**TOTALS**

## CRITERIA FOR PATIENT CLASSIFICATION

1. Category I

A1 and (B1 or B2) and C1 and D1

If all four signs are present, patient is classified into Category I.

2. Category III

If any one of the following is true:

(1) 7 present

(2) 8 present

(3) at least three of (A3, B3, C3, D3) present

(4) A3 and one of (B3, C3, D3) and one "other"

(5) A3 and 2 "other"

(6) two of (B3, C3, D3) and three "other"

(7) one of (B3, C3, D3) and four "other"

(8) six "other"

3. Category II

Patients that do not fall into Categories I or III.

"Being Specialized of Necessity" applies to a patient who requires essentially continuous observation. Such a patient is automatically classified at Category III.

APPENDIX C

## 1. AN EXAMPLE OF A COMPUTER DEVELOPED SCHEDULE.

PROBLEM: To develop a unit schedule for  
a 16-bed nursing unit given the  
following:

<u>Staff</u>	<u>Weekday Coverage</u>	<u>Weekend Coverage</u>
5 RN's	Day Shift = 5	Day Shift = 4
4 NI's	Evening Shift = 2	Evening Shift = 2
4 NA's	Night Shift = 2	Night Shift = 2

THE GENERAL HOSPITAL  
WELCOME TO THE WORK PATTERN SELECTOR



**G**

?

INFORMATION  
\*\*\*\*\*

40

TO SELECT WORK PATTERNS FOR (3) CATEGORIES OF STAFF.  
(EG. RN'S, NI'S, NA'S)

1

•

WEEKEND COVERAGE IS ALSO CONSIDERED:

0

THE PROGRAM SELECTS PATTERNS WHICH GIVE THE MOST EVEN  
COVERAGE.

QUESTIONS ARE ASKED BY THE COMPUTER AND THE PATTERNS ARE SELECTED BASED ON THE ANSWERS GIVEN.

A

EACH PERSON WORKS 5 SHIFTS/WEEK.

MAXIMUM 7 DAY WORK STRETCH(4,5,6,7 WEEK PATTERNS), 8 FOR 3 W.

EVERY PERIOD OFF SHALL BE AT LEAST 2 DAYS DURATION.

## DETAILS -

ANSWER YES OR NO IN SINGLE QUOTES UNLESS SPECIFIED, OTHERWISE.

PATTERNS ARE LISTED WHERE:

BLANK - WORKDAY

O - DAY OFF

## LIMITS -

MAXIMUM NUMBER OF EACH CATEGORY WE CAN SCHEDULE AT A TIME = 7

\*\*\*\*\*

-----  
FIRST, LET'S CONSIDER THE DAY SHIFT.  
-----

HOW MANY R.N.'S ARE NEEDED ON DAY SHIFT?

?  
2

HOW MANY N.I.'S ARE NEEDED ON DAY SHIFT?

?  
2

HOW MANY N.A.'S ARE NEEDED ON DAY SHIFT?

?  
1

-----  
NOW, LET'S CONSIDER THE EVENING SHIFT.  
-----

HOW MANY R.N.'S ARE NEEDED ON EVENING SHIFT?

?  
1

HOW MANY N.I.'S ARE NEEDED ON EVENING SHIFT?

?  
0



HOW MANY N.A.'S ARE NEEDED ON EVENING SHIFT?

?  
1

-----  
NOW, LET'S CONSIDER THE NIGHT SHIFT.  
-----

HOW MANY R.N.'S ARE NEEDED ON NIGHT SHIFT?

?  
0

HOW MANY N.I.'S ARE NEEDED ON NIGHT SHIFT?

?  
1

HOW MANY N.A.'S ARE NEEDED ON NIGHT SHIFT?

?  
1

HOW MANY R.N.'S , N.I.'S , N.A.'S DO YOU HAVE AVAILABLE FOR THE UNIT,  
EXCLUDING THE HEAD NURSE AND TEAM LEADER?

TYPICAL ANSWER MAY BE 5, 4, 4

?  
5, 4, 4

DO YOU REDUCE STAFF ON WEEKENDS?

?  
'YES'

OKAY THEN, LET'S LOOK AT THE WEEKEND COVERAGE.

-----  
FIRST, LET'S CONSIDER THE DAY SHIFT.  
-----

HOW MANY R.N.'S ARE NEEDED ON DAY SHIFT?

?  
2

HOW MANY N.I.'S ARE NEEDED ON DAY SHIFT?

?

2

HOW MANY N.A.'S ARE NEEDED ON DAY SHIFT?

?

0

-----  
NOW, LET'S CONSIDER THE EVENING SHIFT.  
-----

HOW MANY R.N.'S ARE NEEDED ON EVENING SHIFT?

?

1

HOW MANY N.I.'S ARE NEEDED ON EVENING SHIFT?

?

0

HOW MANY N.A.'S ARE NEEDED ON EVENING SHIFT?

?

1

-----  
NOW, LET'S CONSIDER THE NIGHT SHIFT.  
-----

HOW MANY R.N.'S ARE NEEDED ON NIGHT SHIFT?

?

0

HOW MANY N.I.'S ARE NEEDED ON NIGHT SHIFT?

?

1

HOW MANY N.A.'S ARE NEEDED ON NIGHT SHIFT?

?

1

\*\*\*\*\*

## SUMMARY OF COVERAGE REQUIRED

	WEEKDAYS					WEEKENDS			
	RN	NI	NA	TOTAL		RN	NI	NA	TOTAL
D	2	2	1	5	D	2	2	0	4
E	1	0	1	2	E	1	0	1	2
N	0	1	1	2	N	0	1	1	2
TOTAL	3	3	3		TOTAL	3	3	2	

## NUMBER OF PERSONNEL

	NEEDED	AVAILABLE	SELECTED
RN	4	5	5
NI	4	4	4
NA	4	4	4

\*\*\*\*\*

\*

\*

\*

\*

\*

\*

## LIST OF PATTERNS SELECTED

\*\*\*\*\*

## LIST OF PATTERNS FOR R.N.'S

=====

PATTERN NO.	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	00	00	00	00	00
2	00	00	00	00	00
3	00	00	00	00	00
4	00	00	00 0	0 00	0 00
5	00	00	00	00	00
6	00	00	00 0	0 00	0 00
7	00	00	00 0	0 00	0 00

DAILY COVERAGE FOR EACH PATTERN ABOVE

-----

PATTERN NO.	M	T	W	T	F	S	S
1	4	3	3	3	4	4	4
2	4	3	3	4	4	3	4
3	4	3	4	4	3	3	4
4	3	3	4	4	4	4	3
5	4	4	4	3	3	3	4
6	3	4	4	3	4	4	3
7	3	4	4	4	4	3	3

\*\*\*\*\*

LIST OF PATTERNS FOR N.I.'S

=====

PATTERN NO.	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	00	00	00	00
2	00	00	00	00
3	00	00	00	00

DAILY COVERAGE FOR EACH PATTERN ABOVE

-----

PATTERN NO.	M	T	W	T	F	S	S
1	3	2	3	3	3	3	3
2	3	3	3	2	3	3	3
3	3	3	3	3	3	2	3

\*\*\*\*\*

LIST OF PATTERNS FOR N.A.'S

=====

PATTERN NO.	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	00	00	00	00
2	00	00	00	00
3	00	00	00	00

DAILY COVERAGE FOR EACH PATTERN ABOVE  
-----

PATTERN NO.      M T W T F S S

1	3	2	3	3	3	3	3
2	3	3	3	2	3	3	3
3	3	3	3	3	2	3	

\*\*\*\*\*

GOOD-BYE, SEE YOU NEXT TIME.

```

*****
*
*
*      THE GENERAL HOSPITAL
*
*      WELCOME TO THE WORK SCHEDULE ASSEMBLER
*
*
*****

```

DO YOU WANT INFORMATION ON HOW TO USE THE PROGRAM?

ANSWER YES OR NO ENCLOSED IN SINGLE QUOTES.

?

'YES'

\*\*\*\*\*

#### INFORMATION

\*\*\*\*\*

#### PURPOSE -

TO WORK OUT DAILY SCHEDULES FOR (3) CATEGORIES OF STAFF.  
(EG. RN'S, NI'S, NA'S)

#### INPUT -

THE BASIC INPUT IS A PATTERN (SHOWING DAYS OFF AND SHIFTS)  
WHICH MAY BE SELECTED USING "NURSE1" PROGRAM OR WORKED OUT  
INDEPENDENTLY .

#### OPERATION -

THE PROGRAM SCHEDULES STAFF IN A CYCLIC MANNER AND REPORTS  
ON EACH SCHEDULE PRODUCED.

THE OPERATOR ANSWERS A SERIES OF QUESTIONS THAT THE COMPUTER  
ASKS AND CHANGES EACH SCHEDULE UNTIL A SATISFACTORY SHIFT  
COVERAGE AND PERSONNEL MIX IS OBTAINED.

#### DETAILS -

ANSWER YES OR NO IN SINGLE QUOTES UNLESS SPECIFIED OTHERWISE.

THE PATTERN IS ENTERED SHOWING DAYS OFF, AND SHIFTS WHERE:

X - DAY OFF	R - REQUESTED DAY OFF
D - DAY SHIFT	S - SICK LEAVE
E - EVENING SHIFT	O - DAY OWED
N - NIGHT SHIFT	T - NURSING DISTRICT
A - ANNUAL LEAVE	C - CLASS DAY

PATTERN LENGTH IS IN WEEKS.

TYPING CODE FOR PATTERNS:-

0 - DAY OFF	5 - REQUESTED DAY OFF
1 - DAY SHIFT	6 - SICK LEAVE
2 - EVENING SHIFT	7 - DAY OWED
3 - NIGHT SHIFT	8 - NURSING DISTRICT
4 - ANNUAL LEAVE	9 - CLASS DAY

NOTE: CODES 0 - 3 USED IN THIS PROGRAM.

LIMITS -

MAXIMUM PATTERN LENGTH = 7 WEEKS

MAXIMUM NUMBER OF PERSONS IN EACH CATEGORY = 7

\*\*\*\*\*

STAFF CATEGORY?

?

'RN S'

PATTERN LENGTH?

?

5

PATTERN?

?

2 0 0 3 3 3 3 3 3 0 0 1 1 1 1 1 0 0 0 1 1 1 1 1 0 0 0 1 1 2 2 2 2

PATTERN CHOSEN FOR 5 RN S

-----  
MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS  
EXXNNNN NNNXXDD DDDDXXX DDDDDXX XDDEEEE

## SHIFT SCHEDULE FOR 5 RN S

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	EXXNNNN	NNNXXDD	DDDDXXX	DDDDXX	XDDEEEE
2	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX	DDDDXX
3	DDDDXX	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX
4	DDDDXXX	DDDDXX	XDDEEEE	EXXNNNN	NNNXXDD
5	NNNXXDD	DDDDXXX	DDDDXX	XDDEEEE	EXXNNNN
D	2332111	2332111	2332111	2332111	2332111
E	1001111	1001111	1001111	1001111	1001111
N	1111111	1111111	1111111	1111111	1111111

SATISFIED WITH COVERAGE?

?

'YES'

ANY PERMANENT SHIFT STAFF?

?

'NO'

FULL REPORT ON TIME SCHEDULE ?

?

'YES'

\*\*\*\*\*

## FULL REPORT FOR RN S

=====

## SHIFT SCHEDULE FOR 5 RN S

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	EXXNNNN	NNNXXDD	DDDDXXX	DDDDXX	XDDEEEE
2	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX	DDDDXX
3	DDDDXX	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX
4	DDDDXXX	DDDDXX	XDDEEEE	EXXNNNN	NNNXXDD
5	NNNXXDD	DDDDXXX	DDDDXX	XDDEEEE	EXXNNNN
D	2332111	2332111	2332111	2332111	2332111
E	1001111	1001111	1001111	1001111	1001111
N	1111111	1111111	1111111	1111111	1111111



# FULL REPORT ON SCHEDULE FOR RN S -----

MINIMUM WORK STRETCH = 5

MAXIMUM WORK STRETCH = 7

TOTAL DAY SHIFTS = 13

TOTAL EVENING SHIFTS = 5

TOTAL NIGHT SHIFTS = 7

TOTAL NUMBER OF WORKDAYS = 25

NUMBER OF SPLIT DAYS OFF = 0

NUMBER OF WEEKENDS OFF IN 5 = 2

## VIOLATIONS

\*\*\*\*\*

NUMBER OF TIMES EVENING OR NIGHT SHIFT BEFORE WEEKEND OFF = 0

NUMBER OF TIMES EVENING-DAY SHIFT = 0

NUMBER OF TIMES EVENING-NIGHT SHIFT = 0

NUMBER OF TIMES NIGHT-DAY SHIFT = 0

## TOTAL COVERAGE FOR 1 CATEGORY OF STAFF -----

	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
D	2332111	2332111	2332111	2332111	2332111
E	1001111	1001111	1001111	1001111	1001111
N	1111111	1111111	1111111	1111111	1111111

END OF RUN 1

-----

\*\*\*\*\*

SCHEDULE ANOTHER CATEGORY OF STAFF?

?  
•YES•

STAFF CATEGORY?

?  
'NI S'

PATTERN LENGTH?

?  
4

PATTERN?

?

3 3 0 0 1 1 1 1 2 2 0 0 1 1 1 1 1 1 0 0 0 0 3 3 3 3

PATTERN CHOSEN FOR 4 NI S

-----  
MTWTFSS MTWTFSS MTWTFSS MTWTFSS  
NNXXDDD DEEXXDD DDDDDXX XXNNNNN

SHIFT SCHEDULE FOR 4 NI S

-----  
EMPLOYEE MTWTFSS MTWTFSS MTWTFSS MTWTFSS  
1 NNXXDDD DEEXXDD DDDDDXX XXNNNNN  
2 XXNNNNN NNXXDDD DEEXXDD DDDDDXX  
3 DDDDDXX XXNNNNN NNXXDDD DEEXXDD  
4 DEEXXDD DDDDDXX XXNNNNN NNXXDDD  
D 2111222 2111222 2111222 2111222  
E 0110000 0110000 0110000 0110000  
N 1111111 1111111 1111111 1111111

SATISFIED WITH COVERAGE?

?  
'YES'

ANY PERMANENT SHIFT STAFF?

?  
'NO'

FULL REPORT ON TIME SCHEDULE?

?  
'YES'

\*\*\*\*\*

## FULL REPORT FOR NI S

=====

## SHIFT SCHEDULE FOR 4 NI S

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
1	NNXXDD	DEEXDD	DDDDXX	XXNNNN
2	XXNNNN	NNXXDD	DEEXDD	DDDDXX
3	DDDDXX	XXNNNN	NNXXDD	DEEXDD
4	DEEXDD	DDDDXX	XXNNNN	NNXXDD
	D 2111222	2111222	2111222	2111222
	E 0110000	0110000	0110000	0110000
	N 1111111	1111111	1111111	1111111

## FULL REPORT ON SCHEDULE FOR NI S

-----

MINIMUM WORK STRETCH = 6

MAXIMUM WORK STRETCH = 7

TOTAL DAY SHIFTS = 11

TOTAL EVENING SHIFTS = 2

TOTAL NIGHT SHIFTS = 7

TOTAL NUMBER OF WORKDAYS = 20

NUMBER OF SPLIT DAYS OFF = 0

NUMBER OF WEEKENDS OFF IN 4 = 1

## VIOLATIONS

\*\*\*\*\*

NUMBER OF TIMES EVENING OR NIGHT SHIFT BEFORE WEEKEND OFF = 0

NUMBER OF TIMES EVENING-DAY SHIFT = 0

NUMBER OF TIMES EVENING-NIGHT SHIFT = 0

NUMBER OF TIMES NIGHT-DAY SHIFT = 0

# TOTAL COVERAGE FOR 2 CATEGORIES OF STAFF

```

      MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS
D 4443333 4443333 4443333 4443333 4443333
E 1111111 1111111 1111111 1111111 1111111
N 2222222 2222222 2222222 2222222 2222222

```

END OF RUN 2

\*\*\*\*\*

## SCHEDULE ANOTHER CATEGORY OF STAFF?

YES

STAFF CATEGORY?

NA S

PATTERN LENGTH?

3

PATTERN?

0 0 1 1 1 0 0 1 1 2 2 2 2 0 0 1 1 1 1

PATTERN CHOSEN FOR 3 NA S

```

MTWTFSS MTWTFSS MTWTFSS
XXDDDDXX DDEEEEE XXDDDD

```

## SHIFT SCHEDULE FOR 3 NA S

```

EMPLOYEE MTWTFSS MTWTFSS MTWTFSS
1 XXDDDDXX DDEEEEE XXDDDD
2 XXDDDD XXDDDDXX DDEEEEE
3 DDEEEEE XXDDDD XXDDDDXX
D 1122211 1122211 1122211
E 0011111 0011111 0011111
N 0000000 0000000 0000000

```

SATISFIED WITH COVERAGE?

?

'YES'

ANY PERMANENT SHIFT STAFF?

?

'YES'

HAVE YOU SCHEDULED THEM BEFORE?

?

'NO'

HOW MANY PERMANENT SHIFT STAFF?

?

1

PLEASE ENTER 3-WEEK SHIFT STAFF PATTERN FOR 1 PERMANENT SHIFT STAFF.

?

2 2 2 0 0 2 2 2 2 2 2 0 0 2 2 2 0 0 2 2

SCHEDULE FOR 1 PERMANENT SHIFT STAFF

```

EMPLOYEE MTWTFSS MTWTFSS MTWTFSS
1-  EEEXXEE EEEEXX EEEXXEE
   D 0000000 0000000 0000000
   E 1110011 1111100 1110011
   N 0000000 0000000 0000000

```

SATISFIED WITH THE PERMANENT SHIFT SCHEDULE ?

?

'YES'

FULL REPORT ON TIME SCHEDULE ?

?

'NO'

## \*\*\*\*\*SUMMARY REPORT\*\*\*\*\*

## TOTAL COVERAGE FOR 3 CATEGORIES OF STAFF

	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
D	5565544	5565544	5565544	5565544	5565544
E	2232233	2233322	2232233	2232233	2233322
N	2222222	2222222	2222222	2222222	2222222

END OF RUN 3

\*\*\*\*\*

SATISFIED WITH THE COMPLETE SCHEDULE?

?  
'NO'

CHANGE WHICH STAFF CATEGORY?

?  
3

THE PATTERN IS

1	2	3
MTWTFSS	MTWTFSS	MTWTFSS
XXDDDX	DDEEEE	XXDDDD

CHANGE WHICH WEEK?

?  
2

REVISION FOR THAT WEEK?

?  
1 1 1 2 2 2

REVISION NUMBER 1

SHIFT SCHEDULE FOR 3 NA S

---

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS
1	XXDDDX	DDDEEEE	XXDDDDD
2	XXDDDDD	XXDDDX	DDDEEEE
3	DDDEEEE	XXDDDDD	XXDDDX
D	1132211	1132211	1132211
E	0001111	0001111	0001111
N	0000000	0000000	0000000

SATISFIED WITH COVERAGE?

?

'YES'

ANY PERMANENT SHIFT STAFF?

?

'YES'

HAVE YOU SCHEDULED THEM BEFORE?

?

'YES'

OKAY, LET'S LOOK AT THE PERMANENT SHIFT SCHEDULE AGAIN!

PREVIOUS PERMANENT STAFF SCHEDULE

---

EMPLOYEE	MTWTFSS	MTWTFSS	MTWTFSS
1	EEEXXE	EEEEEX	EEEXXE
D	0000000	0000000	0000000
E	1110011	1111100	1110011
N	0000000	0000000	0000000

SATISFIED WITH THE PERMANENT SHIFT SCHEDULE ?

?

'YES'

FULL REPORT ON TIME SCHEDULE ?

?

'YES'

\*\*\*\*\*

## FULL REPORT FOR NA S

=====

## SCHEDULE FOR 1 PERMANENT SHIFT STAFF

```

EMPLOYEE MTWTFSS MTWTFSS MTWTFSS
1    EEEXXEE EEEEEEXX EEEXXEE
   D 0000000 0000000 0000000
   E 1110011 1111100 1110011
   N 0000000 0000000 0000000

```

## SHIFT SCHEDULE FOR 3 NA S

```

EMPLOYEE MTWTFSS MTWTFSS MTWTFSS
1    XXDDDX XXDDDEEE XXDDDDDD
2    XXDDDDDD XXDDDX DDDEEEE
3    DDDEEEE XXDDDDDD XXDDDX
   D 1132211 1132211 1132211
   E 0001111 0001111 0001111
   N 0000000 0000000 0000000

```

## TOTAL COVERAGE NA S AND SHIFT STAFF

```

MTWTFSS MTWTFSS MTWTFSS
D 1132211 1132211 1132211
E 1111122 1112211 1111122
N 0000000 0000000 0000000

```

## FULL REPORT ON SCHEDULE FOR NA S

MINIMUM WORK STRETCH = 3

MAXIMUM WORK STRETCH = 7

TOTAL DAY SHIFTS = 11

TOTAL EVENING SHIFTS = 4

TOTAL NIGHT SHIFTS = 0

TOTAL NUMBER OF WORKDAYS = 15

NUMBER OF SPLIT DAYS OFF = 0

NUMBER OF WEEKENDS OFF IN 3 = 1



## VIOLATIONS

\*\*\*\*\*

NUMBER OF TIMES EVENING OR NIGHT SHIFT BEFORE WEEKEND OFF = 0

NUMBER OF TIMES EVENING-DAY SHIFT = 0

NUMBER OF TIMES EVENING-NIGHT SHIFT = 0

NUMBER OF TIMES NIGHT-DAY SHIFT = 0

TOTAL COVERAGE FOR 3 CATEGORIES OF STAFF

	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
D	5575544	5575544	5575544	5575544	5575544
E	2222233	2223322	2222233	2222233	2223322
N	2222222	2222222	2222222	2222222	2222222

END OF RUN 4

\*\*\*\*\*

SATISFIED WITH THE COMPLETE SCHEDULE?

?

'YES'

SO LONG, SEE YOU NEXT TIME!

```

*****
*
*
*      THE GENERAL HOSPITAL
*
*      WELCOME TO THE WORK SCHEDULE PROJECTOR
*
*
*****

```

DO YOU WANT INFORMATION ON HOW TO USE THE PROGRAM?

ANSWER YES OR NO ENCLOSED IN SINGLE QUOTES.

?  
'YES'

\*\*\*\*\*

INFORMATION  
\*\*\*\*\*

PURPOSE -

TO PRINT:- (1) INDIVIDUAL SCHEDULES AND (2) UNIT SCHEDULE  
OVER A PERIOD OF TIME..

INPUT -

- (1) THE WORK PATTERNS FOR EACH STAFF MEMBER AS FINALIZED  
IN "NURSE2" PROGRAM.
- (2) CALENDAR AND FILE INFORMATION.

OPERATION -

THE PROGRAM PROJECTS WORK-SCHEDULES OVER A GIVEN PERIOD  
OF TIME.

## DETAILS -

ANSWER YES OR NO IN SINGLE QUOTES UNLESS SPECIFIED OTHERWISE.

MONTH ----- NUMBER OF MONTH. EG. 11

DAY OF MONTH --- NUMBER. EG. 22

DAY OF WEEK ---- NUMBER. IE. 1 2 3 4 5 6 7  
S M T W T F S

EG. SUN WOULD BE 1

NAMES ----- FIRST - MAXIMUM OF 4 LETTERS. EG. 'JUDY'

- LAST -- MAXIMUM OF 8 LETTERS. EG. 'SHEPPARD'

STATUS ----- MAXIMUM OF 2 LETTERS. EG. 'RN'

PATTERN LENGTH - IN WEEKS. EG. 4

PATTERN CODE---- SAME AS IN "NURSE2" PROGRAM.

NAME OF UNIT --- MAXIMUM OF 8 LETTERS. EG. '2-S WARD'

## LIMITS -

MAXIMUM FORECAST FOR ANY SCHEDULE = 12 MONTHS

MAXIMUM NUMBER OF STAFF SCHEDULED IN ONE RUN = 21

\*\*\*\*\*

NEW FILE?

?

'YES'

FILE NUMBER?

?

2

WHAT MONTH, DAY OF MONTH, AND DAY OF THE WEEK DO WE START PATTERN?

?

3 4 2

WHAT DAY OF THE WEEK DOES MONTH START ON?

?

6

IS THIS A LEAP YEAR?

?

'NO'

EMPLOYEE'S NAME AND STATUS?

?

'M.', 'ANTLER', 'RN'

PATTERN LENGTH?

?

5

PATTERN?

?

2 0 0 3 3 3 3 3 3 0 0 1 1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 2 2 2 2

PRINT THE INDIVIDUAL SCHEDULE?

?

'YES'

FOR HOW MANY MONTHS?

?

2

\*\*\*\*\*  
 \* SCHEDULE FOR M. ANTLER RN \*  
 \*\*\*\*\*

I MAR I						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
	E	X	X	N	N	N
10	11	12	13	14	15	16
N	N	N	N	X	X	D
17	18	19	20	21	22	23
D	D	D	D	D	X	X
24	25	26	27	28	29	30
X	D	D	D	D	D	X
31						
X						

I APR I						
S	M	T	W	T	F	S
	1	2	3	4	5	6
	X	D	D	E	E	E
7	8	9	10	11	12	13
E	E	X	X	N	N	N
14	15	16	17	18	19	20
N	N	N	N	X	X	D
21	22	23	24	25	26	27
D	D	D	D	D	X	X
28	29	30				
X	D	D				

SCHEDULE ANOTHER PERSON?

?  
 'YES'

EMPLOYEE'S NAME AND STATUS?

?  
 'L.', 'GREENE', 'RN'

PATTERN LENGTH?

?

5

PATTERN?

?

0 1 1 2 2 2 2 2 0 0 3 3 3 3 3 3 0 0 1 1 1 1 1 0 0 0 1 1 1 1 0 0

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'I.', 'BARLETT.', 'RN'

PATTERN LENGTH?

?

5

PATTERN?

?

1 1 1 1 1 0 0 0 1 1 2 2 2 2 2 0 0 3 3 3 3 3 3 3 0 0 1 1 1 1 1 0 0 0

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'D.', 'OAKE', 'RN'

PATTERN LENGTH?

?

5

PATTERN?

?

1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 2 2 2 2 0 0 3 3 3 3 3 3 3 0 0 1 1

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'P.', 'WISEMAN', 'RN'

PATTERN LENGTH?

?

5

PATTERN?

?

3 3 3 0 0 1 1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 2 2 2 2 0 0 3 3 3 3

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'W.', 'ROSE', 'NI'

PATTERN LENGTH?

?

4

PATTERN?

?

3 3 0 0 1 1 1 1 2 2 0 0 1 1 1 1 1 1 0 0 0 0 3 3 3 3

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'T.', 'PARSONS', 'NI'

PATTERN LENGTH?

?

4

PATTERN?

?

0 0 3 3 3 3 3 3 3 0 0 1 1 1 1 2 2 0 0 1 1 1 1 1 1 0 0

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'B.', 'KEATING', 'NI'



PATTERN LENGTH?

?

4

PATTERN?

?

1 1 1 1 1 0 0 0 3 3 3 3 3 3 0 0 1 1 1 2 2 0 0 1 1

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

C., 'LAHEY', 'NI'

PATTERN LENGTH?

?

4

PATTERN?

?

1 2 2 0 0 1 1 1 1 1 0 0 0 0 3 3 3 3 3 3 0 0 1 1 1

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

G., 'MARSH', 'NA'

PATTERN LENGTH?

?  
3

PATTERN?

?  
2 2 2 0 0 2 2 2 2 2 2 2 0 0 2 2 2 0 0 2 2

PRINT THE INDIVIDUAL SCHEDULE?

?  
'NO'

SCHEDULE ANOTHER PERSON?

?  
'YES'

EMPLOYEE'S NAME AND STATUS?

?  
'H.', 'PEACOCK', 'NA'

PATTERN LENGTH?

?  
3

PATTERN?

?  
0 0 1 1 1 0 0 1 1 1 2 2 2 2 0 0 1 1 1 1 1

PRINT THE INDIVIDUAL SCHEDULE?

?  
'NO'

SCHEDULE ANOTHER PERSON?

?  
'YES'

EMPLOYEE'S NAME AND STATUS?

?  
'K.', 'FOSTER', 'NA'

PATTERN LENGTH?

?

3

PATTERN?

?

0 0 1 1 1 1 1 0 0 1 1 1 0 0 1 1 1 2 2 2 2

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'YES'

EMPLOYEE'S NAME AND STATUS?

?

'S.', 'GOSSE', 'NA'

PATTERN LENGTH?

?

3

PATTERN?

?

1 1 1 2 2 2 2 0 0 1 1 1 1 1 0 0 1 1 0 0

PRINT THE INDIVIDUAL SCHEDULE?

?

'NO'

SCHEDULE ANOTHER PERSON?

?

'NO'

UNIT NAME?

?

'NEURO'

NAMES OF HEAD, NURSE AND WARD CLERK?

?

M., BROWN; Y., SMITH

WHAT MONTH, DAY OF MONTH AND DAY OF WEEK DOES SCHEDULE START?

?

3 4 2

WHAT MONTH, DAY OF MONTH AND YEAR DOES SCHEDULE END ?

?

4 14 74

1 of

FILE NUMBER = 2 NUMBER OF EMPLOYEES = 13

THE GENERAL HOSPITAL  
SIX WEEK TIME SCHEDULE

DATE: MAR 4 - APR 14 1974

UNIT: NEURO

1 111111 112222 222233 1111  
4567890 1234567 8901234 5678901 1234567 8901234

DAY OF MONTH	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
NAME	STATUS					
M. BROWN	HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLER	RN	EXXNNNN	NNNXXDD	DDDDXXX	DDDDDX	XDDEEEE
L. GREENE	RN	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX	DDDDDX
J. BARLETT	RN	DDDDDX	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX
D. OAKE	RN	DDDDXXX	DDDDDX	XDDEEEE	EXXNNNN	NNNXXDD
P. WISEMAN	RN	NNNXXDD	DDDDXXX	DDDDDX	XDDEEEE	EXXNNNN
W. ROSE	NI	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD
T. PARSONS	NI	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN
B. KEATING	NI	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX
C. LAHEY	NI	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD
G. MARSH	NA	EEEXXEE	EEEEEX	EEEXXEE	EEEXXEE	EEEEEX
H. PEACOCK	NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE
K. FOSTER	NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX
S. GOSSE	NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD
Y. SMITH	WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
COVERAGE	DAY	5575544	5575544	5575544	5575544	5575544
	EVENING	2222233	2223322	2222233	2222233	2223322
	NIGHT	2222222	2222222	2222222	2222222	2222222

DATE: MAR 4 - APR 14 1974

UNIT: NEURO

1 1111111 1122222 2222233 11111  
 4567890 1234567 8901234 5678901 1234567 8901234

DAY OF MONTH	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
NAME	STATUS					
M. BROWN	HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLE	RN	EXXNNNN	NNNXXDD	DDDDXXX	DDDDXXX	XDDEEEE
L. GREENE	RN	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX	DDDDXXX
I. BARLETT	RN	DDDDDX	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX
D. OAKE	RN	DDDDXXX	DDDDXXX	XDDEEEE	EXXNNNN	NNNXXDD
P. WISEMAN	RN	NNNXXDD	DDDDXXX	DDDDDX	XDDEEEE	EXXNNNN
W. ROSE	NI	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD
T. PARSONS	NI	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN
B. KEATING	NI	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX
C. LAHEY	NI	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD
G. MARSH	NA	EEEXXEE	EEEEEX	EEEXXEE	EEEXXEE	EEEEEX
H. PEACOCK	NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE
K. FOSTER	NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX
S. GOSSE	NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD
Y. SMITH	WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX

COVERAGE	DAY	5575544	5575544	5575544	5575544	5575544
	EVENING	2222233	2223322	2222233	2222233	2223322
	NIGHT	2222222	2222222	2222222	2222222	2222222

CODE:-	D=DAY SHIFT	E=EVENING SHIFT	N=NIGHT SHIFT	X=DAY OFF
	S=SICK LEAVE	A=ANNUAL LEAVE	C=CLASS DAY	O=DAY OWED
	T=NURSING DISTRICT		R=REQUESTED DAY OFF	

ANY CHANGE TO THE UNIT SCHEDULE?

?

'YES'

CHANGE WHICH NUMBER EMPLOYEE ?

?

3

NAME & NEW 6-WEEK SCHEDULE?

?

1. 'BARLETT', 1 1 4 1 1 0 0 0 1 1 2 2 2 2 2 0 0 3 3 3 3 3 3 3 0 0 1 1

?

1 1 1 1 0 0 0 1 1 1 1 0 0 0

ANOTHER CHANGE?

?

'NO'

FILE NUMBER = 2

NUMBER OF EMPLOYEES = 13

THE GENERAL HOSPITAL  
SIX WEEK TIME SCHEDULE

DATE: MAR 4 - APR 14 1974

UNIT: NEURO

		1111111 1122222 2222233 11111					
		4567890 1234567 8901234 5678901 1234567 8901234					
DAY OF MONTH		MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS
NAME	STATUS						
M. BROWN	HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLE	RN	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN
L. GREENE	RN	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE
I. BARLETT	RN	DDADDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX
D. OAKE	RN	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX
P. WISEMAN	RN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD
W. ROSE	NI	NNXXDD	DEEXDD	DDDDDX	XXNNNN	NNXXDD	DEEXDD
T. PARSONS	NI	XXNNNN	NNXXDD	DEEXDD	DDDDDX	XXNNNN	NNXXDD
B. KEATING	NI	DDDDDX	XXNNNN	NNXXDD	DEEXDD	DDDDDX	XXNNNN
C. LAHEY	NI	DEEXDD	DDDDDX	XXNNNN	NNXXDD	DDDDDX	DDDDDX
G. MARSH	NA	EEEXXEE	EEEEEX	EEEXXEE	EEEXXEE	EEEEEX	EEEXXEE
H. PEACOCK	NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD
K. FOSTER	NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE
S. GOSSE	NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX
Y. SMITH	WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
COVERAGE	DAY	5565544	5575544	5575544	5575544	5575544	5575544
	EVENING	2222233	2223322	2222233	2222233	2223322	2222233
	NIGHT	2222222	2222222	2222222	2222222	2222222	2222222



DATE: MAR 4 - APR 14 1974

UNIT: NEURO

1 N11111 112222 222233 11111  
 4567890 1234567 8901234 5678901 1234567 8901234

DAY OF MONTH MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS

NAME STATUS

M. BROWN	HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLER	RN	EXXNNNN	NNNXXDD	DDDDXXX	DDDDDX	XDDEEEE	EXXNNNN
L. GREENE	RN	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX	DDDDDX	XDDEEEE
I. BARLETT	RN	DDADDXX	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX	DDDDDX
D. OAKE	RN	DDDDXXX	DDDDDX	XDDEEEE	EXXNNNN	NNNXXDD	DDDDXXX
P. WISEMAN	RN	NNNXXDD	DDDDXXX	DDDDDX	XDDEEEE	EXXNNNN	NNNXXDD
W. ROSE	NI	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD
T. PARSONS	NI	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD
B. KEATING	NI	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX	XXNNNNN
C. LAHEY	NI	DEEXXDD	DDDDDX	XXNNNNN	NNXXDDD	DEEXXDD	DDDDDX
G. MARSH	NA	EEEXXEE	EEEEEXX	EEEXXEE	EEEXXEE	EEEEEXX	EEEXXEE
H. PEACOCK	NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD
K. FOSTER	NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE
S. GOSSE	NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX
Y. SMITH	WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX

COVERAGE DAY 5565544 5575544 5575544 5575544 5575544 5575544

EVENING 2222233 2223322 2222233 2222233 2223322 2222233

NIGHT 2222222 2222222 2222222 2222222 2222222 2222222

CODE:- D=DAY SHIFT E=EVENING SHIFT N=NIGHT SHIFT X=DAY OFF  
 S=SICK LEAVE A=ANNUAL LEAVE C=CLASS DAY O=DAY OWED  
 T=NURSING DISTRICT R=REQUESTED DAY OFF

ANY CHANGE TO THE UNIT SCHEDULE?

?

'NO'

DO YOU WANT TO PROJECT THE UNIT SCHEDULE ANOTHER SIX WEEKS?

?

'YES'

FILE NUMBER?

?

3

UNIT NAME?

?

'NEURO'

NAMES OF HEAD NURSE AND WARD CLERK?

?

'M.', 'BROWN', 'Y.', 'SMITH'

WHAT MONTH, DAY OF MONTH AND DAY OF WEEK DOES SCHEDULE START?

?

4.15 2

WHAT MONTH, DAY OF MONTH AND YEAR DOES SCHEDULE END ?

?

5 26 74

1 of

FILE NUMBER = 3

NUMBER OF EMPLOYEES = 13

THE GENERAL HOSPITAL  
SIX WEEK TIME SCHEDULE

DATE: APR 15 - MAY 26 1974

UNIT: NEURO

1111122 2222222 23 111 1111111 2222222  
5678901 2345678 9012345 6789012 3456789 0123456

DAY OF MONTH MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS

NAME STATUS

M. BROWN	HN	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX
M. ANTLER	RN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD
L. GREENE	RN	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN
I. BARLETT	RN	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX	XDDEEEE
D. OAKE	RN	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX	DDDDDX
P. WISEMAN	RN	DDDDXX	DDDDDX	XDDEEEE	EXXNNNN	NNXXDD	DDDDXX
W. ROSE	NI	DDDDDX	XXNNNNN	NNXXDD	DEEXXDD	DDDDDX	XXNNNNN
T. PARSONS	NI	DEEXXDD	DDDDDX	XXNNNNN	NNXXDD	DEEXXDD	DDDDDX
B. KEATING	NI	NNXXDD	DEEXXDD	DDDDDX	XXNNNNN	NNXXDD	DEEXXDD
C. LAHEY	NI	XXNNNNN	NNXXDD	DEEXXDD	DDDDDX	XXNNNNN	NNXXDD
G. MARSH	NA	EEEXXEE	EEEEEX	EEEXXEE	EEEXXEE	EEEEEX	EEEXXEE
H. PEACOCK	NA	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD
K. FOSTER	NA	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE
S. GOSSE	NA	DDDEEEE	XXDDDD	XXDDDX	DDDEEEE	XXDDDD	XXDDDX
Y. SMITH	WC	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX	DDDDDX

COVERAGE DAY 5575544 5575544 5575544 5575544 5575544 5575544

EVENING 2222233 2223322 2222233 2222233 2223322 2222233

NIGHT 2222222 2222222 2222222 2222222 2222222 2222222

DATE: APR 15, - MAY 26 1974

UNIT: NEURO

1111122 2222222 23

111 1111111 2222222

5678901 2345678 9012345 6789012 3456789 0123456

DAY OF MONTH

MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS MTWTFSS

NAME STATUS

M. BROWN HN DDDDDXX DDDDDXX DDDDDXX DDDDDXX DDDDDXX DDDDDXX

M. ANTLER RN NNNXXDD DDDDDXX DDDDDXX XDDEEEE EXXNNNN NNNXXDD

L. GREENE RN EXXNNNN NNNXXDD DDDDDXX DDDDDXX XDDEEEE EXXNNNN

I. BARLETT RN XDDEEEE EXXNNNN NNNXXDD DDDDDXX DDDDDXX XDDEEEE

D. OAKE RN DDDDDXX XDDEEEE EXXNNNN NNNXXDD DDDDDXX DDDDDXX

P. WISEMAN RN DDDDDXX DDDDDXX XDDEEEE EXXNNNN NNNXXDD DDDDDXX

W. ROSE NI DDDDDXX XXNNNNN NNXXDDD DEEXXDD DDDDDXX XXNNNNN

T. PARSONS NI DEEXXDD DDDDDXX XXNNNNN NNXXDDD DEEXXDD DDDDDXX

B. KEATING NI NNXXDDD DEEXXDD DDDDDXX XXNNNNN NNXXDDD DEEXXDD

C. LAHEY NI XXNNNNN NNXXDDD DEEXXDD DDDDDXX XXNNNNN NNXXDDD

G. MARSH NA EEEXXEE EEEEEXX EEEXXEE EEEXXEE EEEEEXX EEEXXEE

H. PEACOCK NA XXDDDDX DDDEEEE XXDDDD DDDEEEE XXDDDD DDDEEEE

K. FOSTER NA XXDDDD DDDEEEE XXDDDD DDDEEEE XXDDDD DDDEEEE

S. GOSSE NA DDDEEEE XXDDDD DDDEEEE XXDDDD DDDEEEE XXDDDD

Y. SMITH WC DDDDDXX DDDDDXX DDDDDXX DDDDDXX DDDDDXX DDDDDXX

COVERAGE DAY 5575544 5575544 5575544 5575544 5575544 5575544

EVENING 2222233 2223322 2222233 2222233 2223322 2222233

NIGHT 2222222 2222222 2222222 2222222 2222222 2222222

CODE:- D=DAY SHIFT E=EVENING SHIFT N=NIGHT SHIFT X=DAY OFF  
 S=SICK LEAVE A=ANNUAL LEAVE C=CLASS DAY O=DAY OWED  
 T=NURSING DISTRICT R=REQUESTED DAY OFF

ANY CHANGE TO THE UNIT SCHEDULE?

?  
'NO'

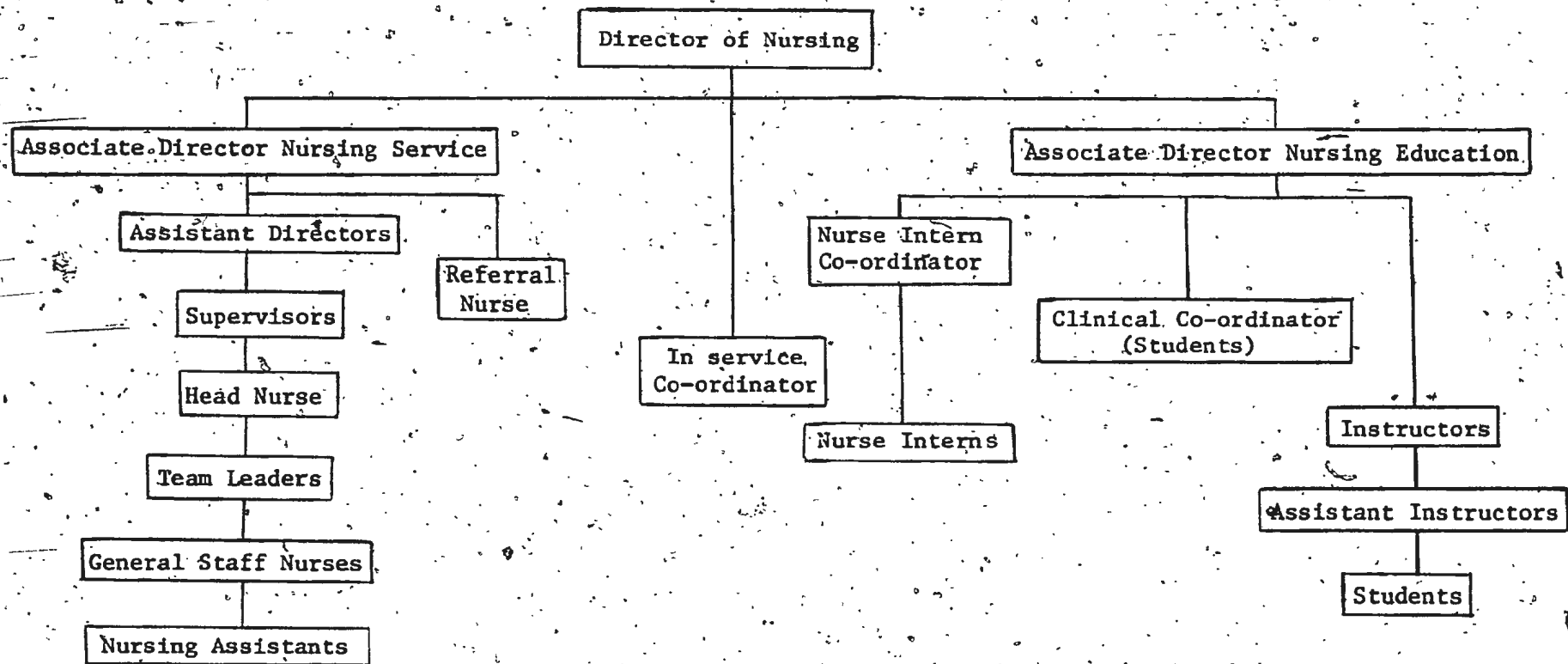
DO YOU WANT TO PROJECT THE UNIT SCHEDULE ANOTHER SIX WEEKS?

?  
'NO'

SO LONG, SEE YOU NEXT TIME!

APPENDIX D

## 1. Nursing Organization Chart.



Nursing Organization Chart.

APPENDIX E

## 1. Further Details on Cyclical Scheduling.



The following two articles in this Appendix explain the cyclical approach to scheduling. Healy's approach is used in the work pattern selector of this system. The patterns listed under "Uneven Distribution Scheduling" are the ones suggested by the work pattern selector. If these patterns are unsuitable, then the user may work out a pattern using Howell's method. In this study part A of Howell's guideline V is used to determine the length of the work pattern.

Appendix E, pp. 167 - 190, not microfilmed  
for reasons of copyright.

Material available for consultation at  
Memorial University of Newfoundland Library.

WORK SHIFT SCHEDULING

# MANAGEMENT

MARCH 1960

No. 2 - 1960

## WORK SHIFT SCHEDULING

### 7 Advantages of Planned Work Shift Schedule

Economically distributes  
manhours

Promotes morale

Balances work and rest  
periods

Promotes efficiency

Gives equal treatment to  
workers

Rotates day off periods

May minimize overtime

The fair and equitable assignment of personnel to work shifts is of primary importance in maintaining good morale. Inequities in shift schedules--real or imaginary--tend to lower morale. And when a worker is unable to forecast when his off-days will occur, his family and other off-the-job activities are disrupted. His morale suffers.

Therefore supervisors whose operations require continuous work shifts, are responsible for scheduling shifts in a manner that is systematic, fair, and effective.

Properly scheduling workers can be a complex job. But the following procedure enables supervisors to do it systematically. This system is based on the desirable principle of consecutive days off. And in this system there are seven basic work weeks. These are shown in Table 1.

These seven weeks can be combined in 127 different ways, but only 50 of these combinations are usable. That is, only 50 give reasonably even coverage and meet requirements for employee satisfaction and fairness. They are shown in Table 2.

The work week used in this article begins on Monday and ends on Sunday. However, the same principles would apply in establishing a different work week as long as it includes 7 consecutive days. In the Air Force the administrative work week has been established as beginning on Sunday and terminating on Saturday. See AFM 40-1, Chapter AF H2, which prescribes the tours of duty.

### 7 Basic Type Work Weeks

	M	T	W	Th	F	S	S
TYPE 1	OFF	OFF					
TYPE 2		OFF	OFF				
TYPE 3			OFF	OFF			
TYPE 4					OFF	OFF	
TYPE 5						OFF	OFF
TYPE 6	OFF						OFF

TABLE 1

Adapted by permission from "Shift Scheduling Made Easy", by William C. Healy, Lt. Col., USAFR, Factory Magazine, October 1959.

NOTE: (THERE WAS NO FEBRUARY 1960 ISSUE OF THIS PERIODICAL)

## 50 BEST FIVE DAY WORK WEEK COMBINATIONS

Types of Weeks  
in Combinations

Number of Shifts  
Produced by  
Combinations

2-WEEK COMBINATIONS  
(2 groups or 2 individuals)

	M	T	W	T	F	S	S
1-3	2	1	1	1	1	2	2
1-4	2	1	1	2	1	1	2
1-5	2	1	1	2	2	1	1
1-6	1	1	1	2	2	2	1
2-0	1	1	1	1	2	2	2
2-4	2	2	1	1	1	1	2
2-5	2	2	1	1	2	1	1
2-6	1	2	1	1	2	2	1
3-0	1	1	2	1	1	2	2
3-5	2	2	2	1	1	1	1
3-6	1	2	2	1	1	2	1
4-0	1	1	2	2	1	1	2
4-6	1	2	2	2	1	1	1
5-0	1	1	2	2	2	1	1

3-WEEK COMBINATIONS  
(3 groups or 3 individuals)

1-3-5	3	2	2	2	2	2	2
1-3-6	2	2	2	2	2	3	2
1-4-6	2	2	2	3	2	2	2
2-4-6	2	3	2	2	2	2	2
2-4-0	2	2	2	2	2	2	3
2-5-0	2	2	2	2	3	2	2
3-5-0	2	2	3	2	2	2	2

4-WEEK COMBINATIONS  
(4 groups or 4 individuals)

1-2-4-6	3	3	2	3	3	3	3
1-3-4-6	3	3	3	3	2	3	3
1-3-5-0	3	2	3	3	3	3	3
1-3-5-6	3	3	3	3	3	3	2
2-3-5-0	3	3	3	2	3	3	3
2-4-5-0	3	3	3	3	3	2	3
2-4-6-0	2	3	3	3	3	3	3

Types of Weeks  
in Combinations

Number of Shifts  
Produced by  
Combinations

5-WEEK COMBINATIONS  
(5 groups or 5 individuals)

1-2-3-4-6	4	4	3	3	3	4	4
1-2-3-5-6	4	4	3	3	4	4	3
1-2-3-5-0	4	3	3	3	4	4	4
1-2-4-5-6	4	4	3	4	4	3	3
1-2-4-5-0	4	3	3	4	4	3	4
1-2-4-6-0	3	3	3	4	4	4	4
1-3-4-5-6	4	4	4	4	3	3	3
1-3-4-5-0	4	3	4	4	3	3	4
1-3-4-6-0	3	3	4	4	3	4	4
1-3-5-6-0	3	3	4	4	4	4	3
2-3-4-5-0	4	4	4	3	3	3	4
2-3-4-6-0	3	4	4	4	3	4	4
2-3-5-6-0	3	4	4	3	4	4	3
2-4-5-6-0	3	4	4	4	4	3	3

6-WEEK COMBINATIONS  
(6 groups or 6 individuals)

1-2-3-4-5-6	5	5	4	4	4	4	4
1-2-3-4-5-0	5	4	4	4	4	4	5
1-2-3-4-6-0	4	4	4	4	4	5	5
1-2-3-5-6-0	4	4	4	4	5	5	4
1-2-4-5-6-0	4	4	4	5	5	4	4
1-3-4-5-6-0	4	4	5	5	4	4	4
2-3-4-5-6-0	4	5	5	4	4	4	4

7-WEEK COMBINATIONS  
(7 groups or 7 individuals)

1-2-3-4-5-6-0	5	5	5	5	5	5	5
---------------	---	---	---	---	---	---	---

BOXED COMBINATIONS USED FOR  
UNEVEN DISTRIBUTION SCHEDULE

TABLE 2

These combinations can be applied to operations requiring the same number of people, of the same skill, on every shift around the clock. This system is known as Even Distribution Scheduling, or EDS.

However, when men of differing work function must rotate shifts (day, afternoon, night) and work weeks, or when a different number of men is required on each shift, we must use a different system, one that we shall call Uneven Distribution Scheduling, or UDS. This system can use only the 18 work-week combinations which appear in boxes in Table 2.

Let us first consider Uneven Distribution Scheduling.

#### Steps in Uneven Distribution Scheduling

There are seven steps to take in UDS:

1. Determine the number of people, by skill, required on each shift.
2. Multiply the number of shifts per day by 7 to find the number of shifts per week, for each skill.
3. Divide the result by 5 to find the number of individuals required in each skill per 5-day work-week.
4. Find the group of work-week combinations corresponding to the number of individuals.
5. Choose one of the combinations from this group.
6. Prepare an initial schedule.
7. Check the initial schedule and make needed adjustments.

#### An Example of Uneven Distribution Scheduling

Here's how the system works on a simple problem.

A combination gate guard-traffic control post must be manned from 1730 to 0930 (2 shifts) seven days a week. We need to figure the best work schedule.

Our first step is to see the number of people required for each shift: one for afternoon (1730-0130) and one for night (0130-0930). Multiplying by 7, we see that there are 14 total shift requirements per week. Dividing by 5 and rounding to the nearest whole number, we see that 3 guards are needed, so we'll need a 3-week combination. From Table 2 we see that there are only two of these combinations that can be used for UDS. We choose the 3-5-0 combination in any sequence to begin with, and then rotate the sequence. From Table 1 we determine "duty" days and "off" days.

Now we can draw up a three-week chart showing duty times for each of the three guards during that period. Guard X will follow the 3-5-0 schedule, Guard Y will follow the 5-0-3 schedule, and Guard Z will follow the 0-3-5 schedule. In order to rotate shifts, we will switch each guard from afternoon to night or vice versa after his off-period, as shown in the following:

Worker	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
Guard X	A	A	A	off	off	N	N	N	N	N	N	off	off	off	off	off	A	A	A	A	A
Guard Y	N	N	N	N	N	off	off	off	off	A	A	A	A	A	A	A	A	off	off	N	N
Guard Z	off	off	A	A	A	A	A	A	A	A	off	off	N	N	N	N	N	N	N	off	off
TOTAL	A	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1
ON																					
SHIFTS	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note that in the three weeks each guard has 15 work-periods, 8 in the afternoon and 7 at night. The extra shift on Wednesday afternoons can be devoted to training. Although there are 8-day work periods, no more than 5 days are worked in any one calendar week. If civilian guards are used there is no overtime.

### A Tougher Problem

Now let's try a tougher problem:

A distinguished visitor taxi service is operated at an Air Force base. It is a 24-hour-a-day service, but experience has shown that 1 driver is sufficient on the night shift. Three drivers each are required for the day and afternoon shifts. Maintenance is performed by two mechanics on the night shift, but one mechanic must be available during the afternoon shift for emergencies when the base shops are closed. Our problem is to find the best schedule to meet these requirements.

Our first step is to see the number of workers, by skill, required on each shift:

Day (0600-1400)	Drivers - 3	Mechanics - 0
Afternoon (1400-2200)	Drivers - 3	Mechanics - 1
Night (2200-0600)	Drivers - 1	Mechanics - 2
TOTAL	7	3

We multiply by 7 to find the number of shifts per week for each:

Drivers: 7 (total shifts per day) x 7 (days) = 49 shifts per week

Mechanics: 3 (total shifts per day) x 7 (days) = 21 shifts per week

Dividing by 5 we find the number of men needed:

Drivers:  $49/5 = 9.8$ , or 10 drivers

Mechanics:  $21/5 = 4.2$ , or 4 mechanics

First we schedule the drivers. Checking Table 2, we find that the seven-week combination, 1-2-3-4-5-6-0, yields 5 man-shifts each day. And we find that the 2-5-0 combination will give us the extra two shifts a day that are needed. Adding them we get a ten-day combination, 1-2-3-4-5-6-0-2-5-0, which makes 50 shifts, or one more than we need. Then we can tentatively schedule day, afternoon, and night shifts, remembering to change each man from one shift to another only after an off-period. Our initial chart will look like the following:

TYPE WEEK	M	T	W	T	F	S	S
1	A	off	off	D	D	D	D
2	D	D	off	off	A	A	A
3	A	A	A	off	off	D	D
4	D	D	D	D	off	off	A
5	A	A	A	A	A	off	off
6	off	A	A	A	A	A	off
0	off	off	N	N	N	N	N
2	N	N	off	off	D	D	D
5	D	D	D	D	D	off	off
0	off	off	A	A	A	A	A

Shifts DAY	3	3	2	3	3	3	3	20	TOTAL
AFT	3	3	4	3	4	3	3	23	
NIGHT	1	1	1	1	1	1	1	7	

After we total the shifts for each day, we notice that we are short one day shift on Wednesday. But we have one afternoon shift too many on Wednesday and Friday.

We can correct this by changing the second week in the sequence from a Type 2 week to a Type 3 week. This gets rid of the extra afternoon shift on Friday and gives the needed day shift on Wednesday.

Now we can calculate how each of the ten drivers, A through J, will be assigned during the 10-week cycle:

Type of Week	Cycle							Weeks									
	M	T	W	T	F	S	S	1	2	3	4	5	6	7	8	9	10
1	A	off	off	D	D	D	D	A	J	I	H	G	F	E	D	C	B
3	D	D	D	off	off	A	A	B	A	J	I	H	G	F	E	D	C
3	A	A	A	off	off	D	D	C	B	A	J	I	H	G	F	E	D
4	D	D	D	D	off	off	A	D	C	B	A	J	I	H	G	F	E
5	A	A	A	A	A	off	off	E	D	C	B	A	J	I	H	G	F
6	off	A	A	A	A	A	off	F	E	D	C	B	A	J	I	H	G
0	off	off	N	N	N	N	N	G	F	E	D	C	B	A	J	I	H
2	N	N	off	off	D	D	D	H	G	F	E	D	C	B	A	J	I
5	D	D	D	D	D	off	off	I	H	G	F	E	D	C	B	A	J
0	off	off	A	A	A	A	A	J	I	H	G	F	E	D	C	B	A

DAY	3	3	3	3	3	3	3	21	TOTAL
AFN	3	3	4	3	3	3	3	22	
NIGHT	1	1	1	1	1	1	1	7	



Our next job is to schedule the mechanics. Since there are only 4 mechanics, and there are 21 shifts to be filled, we will be one shift short per week. We decide that we can afford this, provided that the short shift falls on Saturday. Checking Table 2, we see that the combination 2-4-5-0 is the only one providing for a short shift on Saturday. We can then assign mechanics K, L, M, and N as follows:

Type of Week								Week			
	M	T	W	T	F	S	S	1	2	3	4
2	N	N	off	off	A	A	A	K	N	M	L
4	A	A	A	A	off	off	N	L	K	N	M
5	N	N	N	N	N	off	off	M	L	K	N
0	off	off	N	N	N	N	N	N	M	L	K
AFT	1	1	1	1	1	1	1	7	TOTAL		
NIGHT	2	2	2	2	2	1	2	13			

#### Even Distribution Scheduling

The Even Distribution Scheduling method can be used where the same number and kind of workers are used on each shift continuously. This EDS will:

Set up the most even schedule for any number of men.

Provide relief personnel exactly where needed.

Advance off-days rotation as required.

EDS is based on the fact that all the 50 best combinations are mathematically related. By adding 1 to any of the work-week combinations another group is created. For example, adding 1 to the four-week combination of 1-3-5-0 transforms it into 2-4-6-1. Rearranging the numbers, we get 1-2-4-6, the first combination shown under the four-week listing in Table 2.

Another feature of EDS combinations is that they can be produced by counting by 2's through the seven basic types of work-week. Starting from 0 we get: 0-2-4-6-1-3-5-0-2-4-6. . . Dividing these numbers into groups of two, three, four, five, six, or seven we get the same groups as are listed in Table 2 under the respective headings.

#### An Example of Even Distribution Scheduling

To see how EDS works, let's consider a five-man computer team in the Comptroller's electronic data processing unit. The computer is operated constantly 3 shifts a day, 7 days a week.

First we determine the composition of a team for each shift:

AFSC	AFS	Number needed
68790	Data Processing and Programming Superintendent or	1
68570	Data Processing Machine Supervisor	1
68550 B	Data Processing Machine Operator	1
68530 B	Apprentice Data Processing Machine Operator	1
68730	Programming Specialist	1
68010	Statistical and Data Processing Machine Helper	1
		<u>5</u>

Then we compute the labor requirement:

$3 \text{ (shifts)} \times 5 \text{ (men per shift)} \times 7 \text{ (days)} = 105 \text{ man-shifts per week.}$

Dividing by five ( $105/5=21$ ) we find we need 21 employees, if each is to work a 5-day week with no overtime.

Next we prepare a scheduling chart by using the series of alternate work-week types: 0-2-4-6-1-3-5-0, etc., divided into groups of four, since four five-shift work weeks come nearest to filling the 21-shift schedule. The extra shift is allowed for assignment of a relief man. We then add day, afternoon, and night assignments, one 7-day shift period at a time. The relief man is assigned to relieve each position in turn on successive nights for five nights. This is how our schedule looks:

SHIFT	AFSC	Em- ploy- ees	Work Week Type	M	T	W	T	F	S	S
1	68790	A	0	off	off	D	D	D	D	D
2	or	B	2	D	D	off	off	A	A	A
3	68570	C	4	A	A	A	A	off	off	N
4		D	6	R	N	N	N	N	N	off
5	68550 B	E	1	N	off	off	D	D	D	D
6		F	3	D	D	D	off	off	A	A
7		G	5	A	A	A	A	A	off	off
8		H	0	off	R	N	N	N	N	N
9	68530 B	I	2	N	N	off	off	D	D	D
10		J	4	D	D	D	D	off	off	A
11		K	6	off	A	A	A	A	A	off
12		L	1	A	off	R	N	N	N	N
13	68730	M	3	N	N	N	off	off	D	D
14		N	5	off	D	D	D	D	off	off
15		O	0	off	off	A	A	A	A	A
16		P	2	A	A	off	R	N	N	N
17	68010	Q	4	N	N	N	N	off	off	D
18		R	6	off	D	D	D	D	D	off
19		S	1	D	off	off	A	A	A	A
20		T	3	A	A	A	off	R	N	N
* 21	68550 B	U	5	N	N	N	N	N	off	off

\*Relief man.

we can rotate shifts by moving each individual through day, night, and then successive work periods -- just as with double days -- we can rotate from -- each of the work periods. We can change work week types weekly, or we can rotate every third week, when a cycle is completed.

The chart below shows the schedule extended through two cycles. In the second cycle the work weeks are each shifted forward one day to rotate day off. Note that the scheme of the relief assignment is the same as the bottom of the chart. This assignment to each of the five shifts during the week is shown by the letter "R".

First Cycle		First Cycle													
Shift	Work Week Type	M	T	W	T	F	S	S	D	W	F	S	S	D	M
1	A	off	off	D	D	D	D	D	D	A	A	A	A	A	off
2	B			off	off	D	D	D	D	A	A	A	A	A	off
3	C				off	off	D	D	D	A	A	A	A	A	off
4	D					off	off	D	D	A	A	A	A	A	off
5	E						off	off	D	A	A	A	A	A	off
6	F							off	off	A	A	A	A	A	off
7	G								off	A	A	A	A	A	off
8	H									off	off	off	off	off	D
9	I										off	off	off	off	D
10	J											off	off	off	D
11	K												off	off	D
12	L													off	D
13	M														off
14	N														off
15	O														off
16	P														off
17	Q														off
18	R														off
19	S														off
20	T														off
21	U														off
22	V														off
23	W														off
24	X														off
25	Y														off
26	Z														off

Second Cycle		Second Cycle													
Shift	Work Week Type	T	W	T	F	S	S	D	M	T	W	T	F	S	S
1	A	off	off	D	D	D	D	D	D	A	A	A	A	A	off
2	B			off	off	D	D	D	D	A	A	A	A	A	off
3	C				off	off	D	D	D	A	A	A	A	A	off
4	D					off	off	D	D	A	A	A	A	A	off
5	E						off	off	D	A	A	A	A	A	off
6	F							off	off	A	A	A	A	A	off
7	G								off	A	A	A	A	A	off
8	H									off	off	off	off	off	D
9	I										off	off	off	off	D
10	J											off	off	off	D
11	K												off	off	D
12	L													off	D
13	M														off
14	N														off
15	O														off
16	P														off
17	Q														off
18	R														off
19	S														off
20	T														off
21	U														off
22	V														off
23	W														off
24	X														off
25	Y														off
26	Z														off

But the system... You may find... of work... efficiency.

GUIDELINES FOR CYCLICAL SCHEDULING

Prepared for: AHA-NIN Institute on Staffing the Nursing Service Department,  
April 5-9, 1965, Chicago

Prepared by: John P. Howell, project director, Community Systems Foundation,  
Ann Arbor, Michigan

## GUIDELINES FOR CYCLICAL SCHEDULING

### Introduction

For many years nurses and nursing directors have complained about scheduling and the various methods for solution of its problems. Scheduling of nurses has always been difficult, due mainly to the fact that hospitals need staffing twenty-four hours a day, seven days a week. At many hospitals, part-time people are asked at what hours they can work and then the full-time people are scheduled "around" these periods. It would seem more appropriate, however, to give the full-time people their choice in this matter, as they are able to provide more continuous patient care. Full-time people are also penalized because of unequal "off" periods--some full-time people rarely having a free weekend.

The reasons for these difficulties are to be found in the absence of a central scheduling office. A head nurse who happens to be doing the scheduling for her department does not know the situation in the whole nursing department. Since she is only aware of circumstances on her particular unit, she does not have the total picture that a nursing office does. By establishing control over scheduling, the nursing office is then able to use its float staff much more effectively; as it knows when a unit is under- or over-staffed, it can attempt to make the necessary adjustments.

Cyclical scheduling, a technique that helps to establish staffing requirements and staffing patterns, is one possible solution to this complex problem. By means of cyclical scheduling, a pattern set for a certain number of weeks may be continuously repeated.

Cyclical scheduling has a number of advantages. It can give the nursing director a management tool which will guide her in assigning positions on the nursing unit; it is helpful in coordinating assignments of float nurses; and it can act as a recruitment aid. In addition it will also give fair scheduling to all nurses, allow part-time people to be scheduled around full-time people, and give the nursing director centralized control of staffing nurses. In some cases, it will reduce staff turnover and the cost of the nursing department.

In the article I will attempt to establish guidelines for developing cyclical scheduling patterns. There are an infinite number of types of cyclical schedules which can be developed, depending upon the particular hospital using

the schedule. By following these guidelines, a cyclical schedule which should fit almost any situation can be developed.

Once the working pattern is developed, it must be put to use by filling in the shifts that each of the persons scheduled will work. Furthermore, part-time people can be used to fill in a full-time pattern. For example, when one part-time person works three days and another part-time two days, they can therefore cover one full-time position. Part-time people can also be used as float staff or to cover the extra positions which may be caused by the schedule. Thus if  $4\frac{1}{5}$  people are needed and only 4 people are scheduled, then part-time people could be used to cover the one extra day per week.

#### Guidelines for Cyclical Scheduling

- I. It must first be determined how many of each classification of staff are needed, such as how many R.N.'s, L.P.N.'s, and orderlies for each shift, and so on. Since at the present time there are few quantitative means to determine this (1,2,3,4), methods such as basing the decision on historical figures, comparison to standard figures, and interviews with nursing personnel may have to be used. It must then be decided if the same coverage is needed for each day of the week.
- II. Secondly, using interviews, questionnaires, experience, or policies, determine what type of working patterns the nursing staff likes. Three important variables, each affecting the others, are to be considered, as follows: (1) should there be two, three, or four day weekends; (2) what should be the maximum length of a working stretch; and (3) should the days off be split or together. Illustrating the interdependence of these variables, three-day weekends can be given only if there are longer working stretches (six or seven-day stretches) or more split days. If two day weekends are allowed with no longer working stretches, then more split days must also be given.
- III. At initial interviews with all personnel, determine the willingness of the personnel to rotate. A higher salary could be established for those who work the evening and night shifts or for those who rotate shifts. This condition of employment will become important when the personnel are filled into the developed schedule at a later stage than is discussed within this paper (5).
- IV. Determine how much staff will be required to accommodate the number of positions found in Section I (above). This can be done either on a per-unit basis, on a service basis (i.e., for medical, surgical, OB, Pediatrics), or for the whole nursing department. The size of the base upon which to schedule will depend upon how much rotation between units is allowed. If no rotation is allowed, then the base will have to be one nursing unit. The number of required staff can be determined through the use of the following formula:

$$X = \frac{D}{W}$$

X = required number of people

D = sum of coverages required for each day of week

W = number of working days per week

For example:

W = 5 = number of working days per week for the personnel

D = 5(Monday) + 5(Tuesday) + 5(Wednesday) + 5(Thursday)  
+ 5(Friday) + 5(Saturday) + 5(Sunday) = 35

then:

$$X = \frac{D}{W} = \frac{35}{5} = 7 \text{ required people}$$

V. The next step is to develop the length of the working pattern for the personnel to be scheduled. The length of the pattern chosen will depend upon one of the following two situations:

- A. If the schedule is being developed for a small number of people all in one department, such as laboratory technicians, or admitting office employees, the length of the schedule (number of weeks) should be equal to the number of required people found in Section IV above. Example: if it is found in Section IV that five people are needed, the schedule should be five weeks in length. However, if an uneven number of required personnel were found in Section IV, such as  $4 \frac{1}{5}$  required people, either four or five people could be scheduled on a four or five week cyclical pattern. If four people were scheduled on a four week pattern, one day a week the coverage would be short by one; and if five people were scheduled on a five week pattern, four days a week there would be one extra person (for examples of this see the pattern below). If the number of people found in Section IV is too large for a reasonably short cyclical schedule, the length can be adjusted by establishing the length which, when two is divided into the required number of people (x), x will still be a whole number. For example, 16 people can be put onto an eight week, four week, or two week cyclical schedule, whichever seems desirable.

In the following two schedules the staffing requirement, as found in Section I, is the same -- three people Monday through Sunday. In order to staff three positions seven days a week,  $4 \frac{1}{5}$  people are required. If four people are scheduled for four weeks, one day a week there will be only two people; in the following pattern this situation occurs every Sunday. If five people are scheduled for five weeks, four days a week there will be four people scheduled; in this second pattern four people are scheduled on Monday through Thursday.





- B. If the schedule is being developed for the entire nursing department, where the number of personnel scheduled daily will vary from nursing unit to nursing unit, granting that the same type of pattern is desired by all the personnel, then one pattern to be used by all personnel must be developed. By giving the same pattern to all nurses, equitable scheduling throughout the hospital will be facilitated. Based on experience from scheduling hospitals, this plan has been found to be an effective device for establishing good personnel relations with the nursing staff. Since seven people exactly cover five positions, assuming the same coverage every day of the week, a seven week pattern best fits the schedule. In this way, all seven people can be given the same number and kind of days off during the seven weeks. In other words, during these weeks, each of the seven people will be off two Mondays, two Tuesdays, two Wednesdays, two Thursdays, two Fridays, two Saturdays, and two Sundays.

In regard to departments where the coverage may vary on different days during the week, Section V-A must be used. Moreover if it is decided the the coverage during the week can vary for the whole nursing department, a pattern which will allow for this can be developed. It must first be decided, however, on which days of the week the coverage can vary from the normal requirements. In most cases this will occur on the weekends. If it is decided that on Saturday and Sunday one less person will not impair adequate service, an eight weeks schedule for eight people is best. These eight people will be able to cover six positions Monday through Friday and five on Saturday and Sunday. If only Saturday or Sunday can be reduced by one person, a seven week schedule for seven people is best. The seven people can cover five positions Monday through either Saturday or Sunday and four positions on either Saturday or Sunday, depending on which day reduced coverage is desirable. Scheduling in this way, however, will provide six staff covering on one day a week. This one day can be either set or varied from week to week.

- VI. A. After determining the length of the cycle (Section V) the next step is to develop a working pattern, the choice of which will be based upon the results from Sections I and II.

For example, it might have been found in Section II that the personnel wanted three-day weekends, a small number of seven-day working stretches, and few split days. In addition from Section I it might have been found that the coverage should be the same seven days a week. We can then calculate, as in Section IV, that seven people will be required to cover five positions; and from Section V we find that a seven week schedule should be used. In order to develop the pattern further, it must next be determined how many of each day of the week each person can have off during the full cycle. Generally, this can be ascertained by subtracting the coverage for each day of the week found in Section I from the required number of people found in Section IV. For example, if it was found that eight people were required to cover six positions Monday through Friday and five positions Saturday and Sunday, by subtracting six from eight it would be determined that each of the

personnel could have two (8 minus 6) Mondays through Fridays for the eight weeks, and three (8 minus 5) Saturdays and Sundays.

- B. With the above information in mind, it is now possible to develop a working pattern by means of the following steps:
1. On scheduling paper list a number of people equal to the number of weeks found in Section V (for eight weeks list eight people).
  2. Start at the left hand edge of the scheduling paper and going diagonally down and across the paper, note the days off of each of the personnel, starting with the weekend days. From the above information it is known how many Saturdays and Sundays should be given off for the entire schedule.
  3. The next problem is to note days off during the week. Starting after the first weekend off, count the number of working days which will have been determined in Section II until the next day off. Working only with the first employee on the list, give him the correct number of each day of the week determined from the restrictions found in Section II above.
  4. After setting a working pattern for the first employee, then repeat the sequence of days off for each of the other employees by going diagonally down and across the scheduling paper. Once this is completed, each of the personnel should have two times the length of the cyclical schedule (in weeks) of total days off (assuming a five-day work week). Furthermore, each day should show the number of people off which was required in Section VI-A.
  5. An example of Section VI follows:

**Assumptions:**

- a. two day weekends, no six or seven day working stretches, and a minimum number of split days were found to be desired in Section II.
- b. from Section IV:

$$X = P \cdot \frac{D}{W} = 5 \cdot \frac{7}{5} = 7$$

P = positions to be covered per week = 5

D = number of days coverage to be desired per week for each position = 7

W = number of working days per week by the personnel = 5

From this information it is found that a seven week cycle with seven people covering five positions would provide the most equitable scheduling.

- c. In order to determine how many of each day of the week each person can have off during the seven weeks (from Section VI-A), subtract from the required number of people (seven) the required coverage for each day (five). Therefore two (7 minus 5) of each day of the week will be off for each employee.

With this in mind, we proceed to Section VI-B. Follow the steps outlined there and in the figure below:

One - List seven names on a seven-week schedule.

	Weeks 1							2							3							4							5							6							7						
Names	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S							
1																																																	
2																																																	
3																																																	
4																																																	
5																																																	
6																																																	
7																																																	

Two - Starting at the first full weekend go diagonally down and across, giving each employee a weekend. The weekend for the seventh person will include a Saturday during the seventh week and Sunday during the first week.

	Weeks 1							2							3							4							5							6							7						
Names	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S							
1						00																																											
2													00																																				
3															00																																		
4																												00																					
5																														00																			
6																																												00					
7	0																																													0			

[illegible]

[illegible]

Five - The final step is to assign days off to the other six employees, going diagonally down and across in the same pattern employed for employee number one.

1	0		00		0		00		0		00		0		00		00		
2	00		0		00		0		00		0		00		0		00		00
3		00		00		0		00		0		00		0		00		0	
4	0		0		00		00		0		00		0		00		0		0
5		0		00		0		00		00		0		00		0		00	
6		00		0		00		0		00		00		0		00		0	
7	0		0		00		0		00		0		00		00		0		0

Bix - In order to verify the accuracy of the cyclical schedule as described, check that on each day of the seven weeks two employees are scheduled off and that the remaining five employees are assigned to regular coverage. At this assurance, the cyclical schedule may be considered complete. Also each of the personnel should have a total of 14 days off. (See Appendix for other types of patterns.)

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### APPENDIX

#### FOUR DIFFERENT TYPES OF WORKING PATTERNS



Date Prepared \_\_\_\_\_  
Prepared By \_\_\_\_\_

189

Department \_\_\_\_\_  
 Area \_\_\_\_\_  
 Employee Class \_\_\_\_\_

# CYCLICAL SCHEDULE

Date Prepared \_\_\_\_\_  
 Prepared By \_\_\_\_\_

	1							2							3							4							5							6							7						
EMPLOYEE	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S							
2 Three-day Weekends			7				0	0	0			7			0		5			0	0			4			0	0	0		3			0	0	0		3			6			0	0	0			
2 Seven-day Working					0	0							0	0	0					0	0					0			0	0	0			0	0	0			0			0							
Stretches	0				0							0	0							0	0					0	0				0	0				0	0				0			0					
1 Six-day Working		0				0	0	0			0				0	0					0	0					0	0					0	0				0	0				0						
Stretch			0	0				0			0	0	0						0				0	0				0	0				0	0				0	0				0						
2 Split days			0	0					0	0			0			0	0	0			0				0	0						0	0	0				0	0				0						
	0	0							0	0			0			0	0	0			0				0	0						0	0					0						0					
2 Four-day Weekends			7				0	0	0	0			7			0	0	0	0					7			0	0	0	0		7			0	0	0		7			0	0	0					
5 Seven-day Working				0	0								0	0	0					0	0					0	0	0	0					0	0	0			0			0							
Stretches		0	0							0	0					0	0	0	0					0	0				0	0	0			0	0	0			0	0			0						
0 Split days	0								0	0					0	0					0	0					0	0					0	0					0	0				0					
				0	0	0	0						0						0							0	0						0	0	0				0	0				0					
			0	0								0	0	0	0					0						0	0						0	0					0	0				0					
	0	0								0	0					0	0							0	0				0	0				0	0					0				0					

APPENDIX F

1. Further Details on the Analysis of the Time Sheets.

# Analysis of Time Study Results

The purpose of the time study was to determine the parameters

(I,  $a_1$ ,  $a_2$ ,  $a_3$ ) in the equation:

$$WLI = I + a_1 N_1 + a_2 N_2 + a_3 N_3$$

Each nurse on the unit being studied was asked to fill out (2)

time study forms as shown in Figure 37 for each shift worked. An

example of completed forms for one nurse is shown below:

WORKING TITLE:		UNIT:		DATE: Nov. 14/73		WORKING TITLE:		UNIT:		DATE: Nov. 14/73	
RN		NEURO		SHIFT: DAY		RN		NEURO		SHIFT: DAY	
TIME	CODE	TIME	CODE	TIME	CODE	TIME	CODE	TIME	CODE	TIME	CODE
7:50		:10		:30		11:50		:10		:30	
:55	I-1	:15		:35	D-2	:55	D-3	:15	D-2	:35	D-1
8:00		:20		:40		12:00		:20		:40	
:05		:25	I-2	:45		:05		:25		:45	
:10	D-3	:30		:50		:10	D-2	:30		:50	
:15		:35		:55		:15		:35		:55	
:20		:40		11:00		:20		:40		3:00	
:25	I-1	:45		:05		:25	I-1	:45	D-1	:05	D-3
:30		:50		:10	D-1	:30		:50		:10	
:35		:55	I-1	:15		:35		:55		:15	
:40		10:00		:20		:40		2:00		:20	
:45	I-2	:05		:25		:45		:05		:25	
:50		:10		:30		:50	D-3	:10	D-3	:30	
:55		:15		:35	D-3	:55		:15		:35	I-1
9:00		:20	D-2	:40		1:00	D-2	:20		:40	
:05		:25		:45		:05		:25	D-1	:45	

## CODE:

### INDIRECT CARE

- I-1 = Paperwork, meetings, telephone
- I-2 = Other

### DIRECT CARE

- D-1 = Patient in Class 1 (Self-care)
- D-2 = Patient in Class 2 (Partial-care)
- D-3 = Patient in Class 3 (Total-care)

## CODE:

### INDIRECT CARE

- I-1 = Paperwork, meetings, telephone
- I-2 = Other

### DIRECT CARE

- D-1 = Patient in Class 1 (Self-care)
- D-2 = Patient in Class 2 (Partial-care)
- D-3 = Patient in Class 3 (Total-care)

Figure 37. Example of Completed Time Study Form.

The parameters in the equation are related to those recorded on the time study form in the following manner:

$$I = (I - 1) + (I - 2)$$

$$a_1 = D - 1$$

$$a_2 = D - 2$$

$$a_3 = D - 3$$

The steps in the analysis of the time study forms for each shift are (refer to Figures 37, 38):

1. Consider each person separately.
2. Add the number of five minute intervals recorded for each code (I - 1, I - 2, D - 1, D - 2, D - 3).
3. Convert the total of each code to minutes. Each interval equals five minutes.
4. Tabulate each person's total as shown in Figure 38.
5. Convert overall total for each code to hours.
6. Record the number of patients in each category ( $N_1$ ,  $N_2$ ,  $N_3$ ) as obtained from Patient Classification Form.
7. Add I - 1 and I - 2 to obtain I.



8. Divide each of  $D - 1$ ,  $D - 2$ ,  $D - 3$  by  $N_1$ ,  $N_2$ ,  $N_3$  respectively to obtain  $a_1$ ,  $a_2$ ,  $a_3$ .

$$\text{i.e. } a_1 = \frac{D - 1}{N_1} ; a_2 = \frac{D - 2}{N_2} ; a_3 = \frac{D - 3}{N_3}$$

9. Record the results in summary form as shown in Table 2.
10. The results in Table 2 are averaged over a period of time to obtain estimates of  $(I, a_1, a_2, a_3)$ .

A statistical analysis of the results in Table 2 was not attempted because of insufficient data. However, if the time study was done over a longer period of time, then a more rigorous statistical analysis of the results would be permitted. For practicability, it was desirable to keep the analysis of the data simple so that implementation would be easy at a later stage.









